The Marvels of Our Bodily Dwelling

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Mary Wood-Allen.

THE MARVELS

OF

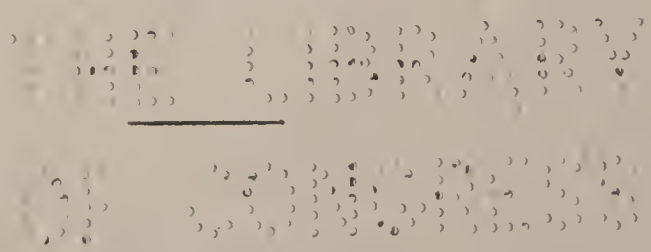
OUR BODILY DWELLING

PHYSIOLOGY MADE INTERESTING

Suitable as a Text-book or Reference Book in Schools,
or for Pleasant Home Reading

BY MARY WOOD-ALLEN, M. D.

Author of "Teaching Truth," "Child-Confidence Rewarded,"
"Almost a Man," and joint author of "The Man
Wonderful in the House Beautiful."



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PREFACE.

"MENS sana in corpore sano," is a sentence with which we were familiar forty years ago. We repeated it glibly in the original and could translate it into equivalent English, "A sound mind in a sound body," but had little comprehension of its full import which even now is but beginning to dawn upon the world. Illnesses were then considered dispensations of Providence; we are now coming to see that we are responsible not only for our own vigor but for that of coming generations. Thus the practical value of physiology is recognized, and nearly every State in the union has passed a law compelling its study in the public schools. To make it interesting, therefore, is worthy the attention of educators.

Teaching by metaphor, parable, and allegory has been the method of many of the wisest teachers. It is said of Jesus that "without a parable spake he not unto them," so we may hold it as not beneath the dignity of instructors of to-day to use the same manner of presenting the truth.

No one can claim originality in comparing the body to a house, for that comparison is as old as literature. Ecclesiastes refers to "the day when the keepers of the house shall tremble and those that look out of the windows be darkened and the door shall be shut in the streets." Abernethy uses a homely figure when he says, "The kitchen — that is, your stomach — being out of order, the garret — the head — cannot be right, and every room in the house becomes affected. Remedy the evil in the kitchen, and all will be right in parlor and chamber."

We quote from Tennyson's "Deserted House:"

"Life and Thought have gone away
Side by side,
Leaving door and windows wide;
Careless tenants they.

"All within is dark as night:
In the windows is no light;
And no murmur at the door,
So frequent on its hinge before."

The author in this volume has united metaphor with scientific facts, and even in this she cannot claim originality. Early in the present century Alcott wrote of "The House We Live In," and later writers on physiology have followed in his footsteps. But the simile is still

of interest to the juvenile mind and, as science is ever making discoveries, there is a demand for new and interesting works on physiology.

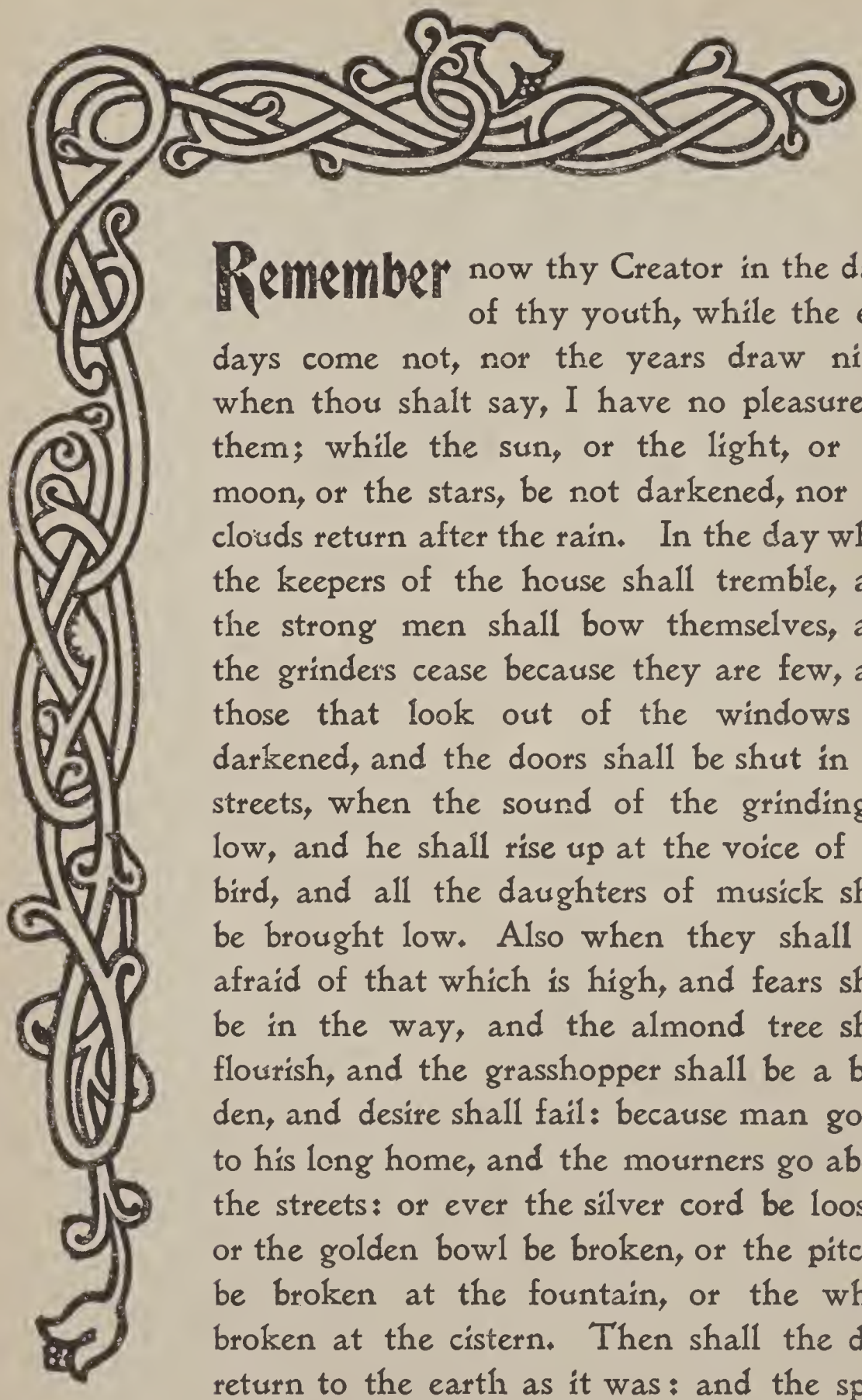
The author would be glad to acknowledge all sources of information but that would be an almost endless task. She has laid under contribution the latest scientific authorities and believes that this book will be found abreast of the science of to-day, holding ever to truth as it now presents itself, and never sacrificing facts to the allegory.

The book is intended for home use or as a supplementary reader, text-book, or reference book in schools.

With thanks to the friends whose words of appreciation have given her encouragement, and to the dear daughter whose quick intelligence and willing fingers have ever been at her command, the author presents this book to the public with the prayerful hope that it may awaken a deep and living interest in this marvelous mansion, stimulating to such study of and obedience to the laws of physiology as will insure that sound body which is the beautiful dwelling-place of a sound mind.

MARY WOOD-ALLEN.

Ann Arbor, Mich., Oct. 19, 1894.



Remember now thy Creator in the days of thy youth, while the evil days come not, nor the years draw nigh, when thou shalt say, I have no pleasure in them; while the sun, or the light, or the moon, or the stars, be not darkened, nor the clouds return after the rain. In the day when the keepers of the house shall tremble, and the strong men shall bow themselves, and the grinders cease because they are few, and those that look out of the windows be darkened, and the doors shall be shut in the streets, when the sound of the grinding is low, and he shall rise up at the voice of the bird, and all the daughters of musick shall be brought low. Also when they shall be afraid of that which is high, and fears shall be in the way, and the almond tree shall flourish, and the grasshopper shall be a burden, and desire shall fail: because man goeth to his long home, and the mourners go about the streets: or ever the silver cord be loosed, or the golden bowl be broken, or the pitcher be broken at the fountain, or the wheel broken at the cistern. Then shall the dust return to the earth as it was: and the spirit shall return unto God who gave it.

Eccl. 12 : 1–7.

TABLE OF CONTENTS.

PART I.

CHAPTER I.

PAGE.
INTRODUCTORY 13

CHAPTER II.

THE FRAMEWORK 17

CHAPTER III.

THE WALLS AND MACHINERY 23

CHAPTER IV.

THE PLUMBING 33

CHAPTER V.

THE SHEATHING 38

CHAPTER VI.

THE THATCH 41

CHAPTER VII.

THE UPPER STORY, OR CUPOLA 43

CHAPTER VIII.

THE GENERAL OFFICE 47

CHAPTER IX.

The Reception Room and Hall 50

CHAPTER X.

The Kitchen 56

CHAPTER XI.

The Store Room 61

CHAPTER XII.

The Dining Room 63

CHAPTER XIII.

The Force Pump 69

CHAPTER XIV.

The General Manager 75

CHAPTER XV.

The Servants 80

CHAPTER XVI.

The Purifying Apparatus 85

CHAPTER XVII.

The Heating Apparatus 97

CHAPTER XVIII.

The Laboratory, Manufactory, and Store-House 103

CHAPTER XIX.

The Housekeeper's Closets 108

CHAPTER XX.

The Electrical Apparatus 114

CHAPTER XXI.

The Wonderful Clock 122

CHAPTER XXII.

Regulator and Mainspring 126

CHAPTER XXIII.

Special Watchmen 132

CHAPTER XXIV.

The Windows 140

CHAPTER XXV.

The Photographic Camera 143

CHAPTER XXVI.

The Music Room 158

CHAPTER XXVII.

The Orchestrion 165

CHAPTER XXVIII.

The Library 172

CHAPTER XXIX.

The Picture Gallery 182

CHAPTER XXX.

The Chamber of Peace 185

PART II.

CHAPTER I.

HELPFUL GUESTS 193

CHAPTER II.

SPICY VISITORS 202

CHAPTER III.

QUESTIONABLE GUESTS 207

CHAPTER IV.

TREACHEROUS COMPANIONS 214

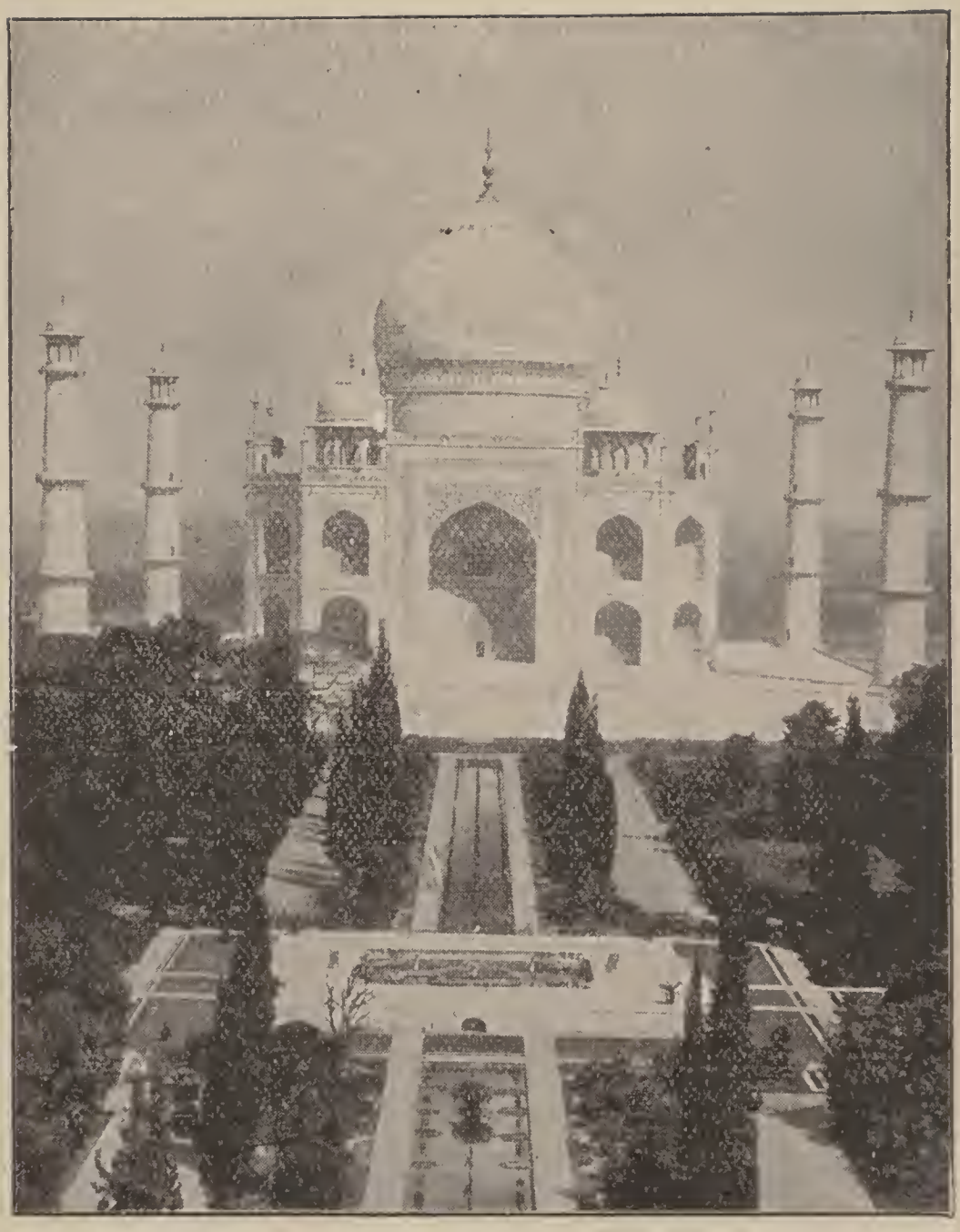
CHAPTER V.

A DECEITFUL FRIEND 220

CHAPTER VI.

THE FOE OF THE HOUSEHOLD 243

PART I.



THE TAJ MAHAL.

A Supplementary chapter, entitled "THE BIRTH-CHAMBER," can be obtained by sending ten cents in stamps to the publishers,—

The Wood-Allen Publishing Co.,
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CHAPTER I.

INTRODUCTORY.

A GREAT many, many years ago, people thought they could see each other and — you think we see each other now, do you, Master Know-all? You will probably be surprised when I tell you that you never saw any one in your life, and no one ever saw you. How do we know each other then, you ask? — Why, by our houses, of course. We see a light in the window, or hear a voice from the open door, and know that the person is at home, but we never see him. Another strange thing is that our houses are all built after the same plan, have each just so many rooms, arranged in just the same order, with just the same number of doors and windows. You shake your head as if you scarcely believed me, but I assure you I am telling you only the truth. The real, thinking, enjoying, knowing *you*, is shut up, a prisoner in his house, and will never go out of it as long as you live.

You entered this house when it was very small, and found yourself a prisoner in it. I

fancy you did not like it very well, for you cried out for help, and a good fairy named Aura rushed into your house and took possession of one of the empty rooms, and has made her home there ever since, and with Aura came the gift of earthly life. May be you will better understand me if I tell you that Aura is the Latin name for air.

Have you ever taken much interest in learning about your body and how to keep it in good repair? If a man builds a house of brick or stone, he is interested in keeping it in order; he insures it against fire, and if the roof leaks or a window is broken, he does not think it an evidence of good sense to be indifferent, but he calls the roofer or glazier at once to repair damages. And yet he could pull this house down and rebuild it, he could sell it or give it away, or he could move out and leave it to take up his abode in another dwelling; but he can never have but one bodily house, and this he cannot sell nor give away. He can tear it down, but he cannot rebuild it, and when he moves out and leaves it, he is done with earthly life. It is, therefore, very important that he should study this house and its needs, so that he may know how to keep it in repair for many years of happy, useful occupancy.

Let us study the body as a house in which we dwell here on earth, a house created by a divine Architect, fitted up with every comfort, divided into many rooms, each with its own appropriate furniture and adapted to its own especial use. It is a beautiful building, more exquisitely adorned than any structure of man's creation.

In India is a wonderful building called the Taj Mahal, and people journey from the farthest parts of the earth to gaze with admiring awe upon its magnificence. It took twenty thousand workmen seventeen years to build it, and it is said to have cost fifty millions of dollars. Still, after all, it is only a tomb, erected by the Emperor Shah Jehan in memory of the Empress Mumtazi Mahal, his beautiful, cultured, and beloved wife.

But your bodily house is more marvelous and beautiful than the Taj Mahal. Its design is more wonderful and complicated, its decorations more exquisite, its value far greater. Then, too, it is not a tomb, not a useless monument to a dead empress, but it is the abode of an immortal being in which he finds shelter; it is a workshop where he carries on many wonderful processes; it is a tool through which he becomes acquainted with the outside world and by means of which he accomplishes great results. As man is able to

carry out the projects which his mind conceives only through the use of his bodily forces, it behooves him to learn its powers, cultivate its organs, study its laws, and reverence its Creator.

CHAPTER II.

THE FRAME-WORK.

DID you ever see a house walk? I saw one moving along the street the other day, but it was not going very fast. An old colored man, who was once asked how he was progressing on his heavenward way, replied that he was "inching along." That was the way this house progressed, although there were ropes and wheels and boards and rollers and a man and a horse to assist it. Our bodily house is four stories high, but by means of mechanical contrivances it can walk, or run, or turn hand-springs, or climb trees, or dive into the water, or turn itself upside down and stand on the upper story.

About two hundred pieces of a material called bone are united to form the frame-work of the house, and these pieces are long, short, flat, or irregular in shape, and when all are fastened together, they form what is called the "skeleton." You know that boards are united by splicing, dove-tailing, or mortising, or by means of contrivances that hold them close together, and yet

permit easy motion between them. We find the same methods of union in the frame-work of the bodily house. The dome of the topmost story is formed of many pieces of bone united by dove-tailing or by splicing, which allows the dome to expand and grow. The third story, called the thorax, has a frame-work of curved beams which we commonly speak of as the ribs. They are attached to the spine in the back (of this we shall speak presently), and the upper seven of them on each side are fastened to a bone in front known as the sternum, or breast bone. From the thorax rises the short tower of the neck, which supports the upper story or head. The second story is called the abdomen and its only bony structure is the spine. The lowest story of all is called the pelvis and has a large bony frame, solid and strong, for it not only has to support the stories above, but to it are attached the jointed stilts, or legs, which carry the house about.

Our residences are often adorned with columns; our bodily dwelling has but one, called the spinal column, but that is of great importance. It unites the upper and lower stories and forms part of the frame-work of the second and third stories. The spinal column is long and flexible and composed of twenty-six bones; in shape they are

like short spools with handles on one side, and are set one on the other, the handles all pointing the same way. I said one on the other, but, in reality, there are cushions of cartilage between each two bones, and this is what makes it possible to bend the column, for the cushions will yield on pressure. You see that everything about our house must be arranged to allow motion. The spine is not straight, but curves gently, something like an elongated letter S, and this makes a sort of spring which yields to the shock of jumping and walking, and prevents the furniture and machinery in the different rooms from being jarred out of place or otherwise injured.

In the mechanical appendages, which we call arms and legs, different sorts of movable joints are employed. The ball-and-socket joint is one in which the rounded end of one bone fits into a cup-like hollow in another bone. The hinge-joint allows of motion only in one direction, like the hinge-joint of a door. A boy could not play base ball very well if he had a ball-and-socket joint at elbows and knees, and a hinge-joint at hips and shoulders, so he will appreciate the fact that this condition is reversed, and that the joints which allow freedom of motion are placed at hip and shoulders, and the hinge-joints at elbows and knees. The upper story, or head,

is united to the spinal column by a pivot joint; that is, a projection of one bone is surrounded by a ring of another bone, and that allows a turning and twisting motion.

I have not time to tell you about all of the admirable contrivances of the frame-work of the House Wonderful, but I advise you to study it. Instead of thinking of the bony skeleton as a frightful thing, consider it a marvelous piece of machinery, wonderfully adapted to a designed purpose, and affording lessons in mechanism to the wisest builders and engineers.

Now perhaps you will say, "You told us that the frame-work of the body is made of bone, but what is bone made of?" The chemist tells us that bones are made of animal and earthy matter, and that we can prove this for ourselves if we wish. We can destroy the animal matter by burning the bone, and the earthy matter thus left will still keep the shape of the bone, but it will crumble to pieces at the slightest touch. If we put two ounces of muriatic acid in one pint of water, and soak a bone in it for two or three days, the earthy matter will be dissolved, while the shape of the bone will be unchanged. It will be so flexible that we can tie it in a knot without breaking it. This might make it very pretty to look at, but such bones

would not make a very solid frame-work for our bodily house, and so it is quite important that we should learn how bones grow and whether there is anything we can do to make them strong. The bones of little children are mostly of animal matter so that they bend easily and are not so easily broken. The bones of older people break more readily because they have so much larger proportion of earthy matter. When we come to talk of the guests which man entertains in his bodily dwelling, we shall have something to say of how bones may be made strong and kept in good health.

The foundations of buildings are made of stone and cemented with mortar, and mortar is made of lime. Bones are made strong by lime in various forms, so they are not unlike foundations after all. If we could look into the bones of a living child, we should see them changing from the soft, flexible bones of the baby to the strong, hard bones of the man by the accumulation, at various points, of little bits of lime, or calcareous matter. They are beginning to ossify, or *bonify*, if we may make a word. These limy spots grow bigger and bigger until they unite in one hard bone. But, although the bones are hard, they are not solid. Even flat bones are made with little holes all through

them, which give them a sort of spongy appearance, and the shafts of the long bones are hollow.

The ends of the long bones are large and rounded to form the joints, and are tipped with cushions of cartilage, or gristle. They are held together by bands called ligaments, and are enclosed in a sac having the power to make a fluid which, in a way, oils the joints. At railway stations you have often seen a man oiling the wheels of a train; or perhaps the train stopped between stations, and when people asked, "What is the matter?" the answer was, "Hot-box." Looking out of the window, you have seen men pouring water on a smoking wheel, and were told that the friction had been so great that smoke, or even fire, had resulted. And that was perhaps because some one had forgotten to oil that wheel. But the machinery of our bodily house oils itself, and that saves us a great deal of anxiety for fear that we may forget some important part.

The frame-work is held together by the white, shining ligaments, which are tough and strong, but flexible. So now we have the frame-work jointed and tied together, but it hangs still and motionless.

CHAPTER III.

THE WALLS AND MACHINERY.

THE walls of the buildings at the great Columbian Exposition were covered with a material called staff, a composition of plaster of Paris which can be formed into many beautiful shapes, in time becoming hard and unchangeable. The walls enclosing the various apartments of our bodily dwelling are made of a substance called muscle, a material which permits the house to assume many shapes and change them often, and instead of being injured by the constant variety of attitudes, the walls grow stronger the more they are used. Muscles not only form the walls, but they are also the machinery for moving the bony frame-work, so muscles cover the arms and legs as well as the trunk of the body.

I once went into a Swedish movement room where, making a great din, were many machines, the purpose of which was to exercise the various parts of the body, and people were going from one to another to be exercised. Here was a machine that shook the feet sidewise; another

that vibrated them up and down; here, a machine that twisted the body; and here, one that lifted and dropped the shoulders; and all the machines were running at the same rate of speed, and repeating the motions every so often without variation.

"This is very clever," I thought, and then I remembered our bodily dwelling, and said, "How much more is its mechanism to be admired! There is no noise, the movements vary in speed at any instant, as Man wills, and all are combined in one compact machine always at hand and ready for use, so that he does not have to go to one place to shake his hands and to another to shake his feet, and to still another to twist his body."

But what moves this muscular machinery? In the Swedish movement room we could see the whirling wheels and bands and we knew that in another room was an engine that transmitted power through shafts to them. But we cannot see such an arrangement in our muscles. This brings me to tell you of the wonderful properties of muscles. The first I shall name is contractility. When you want some one to know what strong muscles you have, you ask him to feel of your arm, and then you clinch your fist, and bend your elbow and say, "Can you feel it

swell ?" It was the swelling of the muscle that made the elbow bend. The muscle contracted and grew shorter and at the same time larger around. This is what is meant by contractility, and it is by this property of muscle that all movements are made. We have little idea of the force with which muscles contract, they move so easily, but we are told that with a ten-pound weight in the hand the muscles that bend the elbow contract with a force of two hundred pounds. It is also said that a muscle contracts better when it has a weight to lift than when it has none ; so it would seem that muscles are quite like folks, for I have often noticed that when people have nothing to do, it is very hard to get them to work ; but when they have a great deal to do, they do n't mind adding to their labors.

The second property of muscles is irritability. That does not mean that they get cross if called on to work, but it means that they respond to stimuli. A boy that is hopping about in a lively manner while being punished, is responding to the stimulus of the whip. When he goes quietly to obey his father's orders, he is responding to the stimulus of a command. The usual stimulus of the muscles is will-power sent over the nerves. But muscles also respond to the

stimulus of heat, or to pricking, or pinching, or to electricity.

Muscles have also the property of elasticity, that is, of going back to their original length after being stretched, as a piece of rubber does; and that is an important quality, you see, or it might be a serious matter to stretch our muscles, and we would be hindered in doing many things we want to do for fear we could not get our muscles back again as they were. But our muscles are always slightly on the stretch. If it were not so we should be obliged to "take in slack," as it were, whenever we want to make a motion before the movement could begin; but because they are always slightly stretched, they can begin to contract as soon as the stimulus is felt.

If muscles were used only as the walls of our house, they might be laid over the frame-work in flat masses, but as they are the motor power to lift and move the bony levers, they must be constructed and attached with that object in view.

A muscle is made up of a bundle of fleshy strings called fibers, and each fiber is made up of very fine, small threads called fibrils. Each fiber is wrapped in a thin membrane, and a bundle of fibers wrapped in another membrane makes a mus-

cle. Fibrils are finer than cobweb, so fine, indeed, that it would need many thousands of them to make a bundle an inch thick. You will better understand how muscles are made, perhaps, if you examine some spool of cotton. You may think it is all of one piece, but by twisting it toward you, you will discover three strands; each of these can be separated into still finer strands, and each of these into finer ones still. These last represent the fibrils. There is one difference, however, between fibers of thread and those of muscle. In thread the fibers are twisted together; in muscles, they lie side by side and are held together by a fine network of connective tissue; fat is packed around to fill all the spaces and form cushions to round out the body and make it look plump. Each muscle has a thick middle part and tapers at the ends into a strong white cord or band, called a tendon, and these tendons are fastened to the bones. There are more than twice as many muscles as bones, that is, nearly five hundred. You see, they work in pairs that oppose each other. It is not always "a long pull and a strong pull and a pull all together" with the muscles, but it is more like a "you pull against me and I'll pull against you, and between us we'll keep things straight." So when the work of one muscle is to bend any

part of the body, there will always be found an opposing muscle to straighten it. Those which bend are flexors. Those which straighten are extensors.

Think what a complicated machine this body is! Why, it takes six little muscles to turn the eyeballs in various directions, and there are about fifty in the arm and hand.

Muscles are of different shapes. Some round, some flat, some long, others short, some very large, and some very small, and all have names. Sometimes the names are bigger and longer than the muscles themselves. For instance, the one that lifts the corners of the mouth and expands the nostrils is called the *Levator labii superioris alæque nasi.* Just think what a trouble it would be to call it by name every time you want it to work. Or imagine that you could never frown unless you called on the *orbicularis palpebrarum* to pucker your forehead for you. It is a good thing for us that we can learn to manage our bodily machinery without knowing anything about the Latin names of the various parts, and the boy enjoys climbing trees even if he knows nothing about the *Latissimus dorsi* that pulls his arms back and enables him to climb.

Walking through the streets of a Southern city, my attention was attracted by a row of

dilapidated tenement houses. The roof of one house sank in the middle until it made me think of a "sway-back" horse. One house had leaned over to one side until it seemed that it must certainly fall, and two had settled backward so that they looked as if they were tired, and were just going to sit down. They were picturesque, but no one would earnestly desire to live in them, and to my eye a body that caves in at the thorax, and curves out at the shoulders, and whose neck is a veritable leaning tower with the cupola balanced at a precarious angle, is not to be admired, but most certainly to be avoided.

The erect attitude of the body maintains a vertical line from the center of the head down through the shoulders and hips to the ground. If the line between hips and shoulders is in any degree oblique, the body is not balanced on the balls of the feet as it ought to be, but rests too much on the heels. If we closely observe people in our streets, we shall see that the majority carry the shoulders back of the hips. This throws the body out of balance, and, as a consequence, the head is projected forward, the back is rounded, the chest is compressed, the abdomen made prominent, and the beautiful curves of the spine entirely changed. This at-

titude is not only unhealthful but ungraceful, and effectually prevents a dignified carriage and gait.

The habit of stooping is often acquired in schools, and parents, seeing the shoulders becoming rounded, keep up a continual cry of, "Draw your shoulders back;" and in the attempt to obey this order, the vertical line before mentioned becomes an oblique line, and the ungainliness of attitude is emphasized rather than overcome.

To prevent or to cure round shoulders we have only to remember that the cause is not in the shoulders but in the disuse of those muscles which should hold up the front of the body. The military attitude accomplishes the desired result. The orders are to elevate the chest, draw in the chin, draw back the abdomen, and let the arms hang naturally. To follow this rule is at once to overcome the round shoulders.

If, instead of continually blaming the shoulders and trying to correct them, we should give our thought and attention to the strengthening of the muscles of the trunk of the body, especially the front waist-muscles, we should have adopted the most effectual means of procuring an erect and graceful attitude. Holding the chest well up is very important, and by a very simple method we can be sure that we accomplish this.

Stand with the face to a blank wall, the toes touching, now bring the chest up to the wall, keeping the abdomen back so that there will be a space between it and the wall. This is about the correct position. At first we may feel as if we were falling forward, but a glance into a mirror, as we stand sidewise before it, will show us that our attitude is merely an erect one, and this glance also will prove to us that this position adds greatly to the beauty and dignity of the person ; more than that, it adds to the health, because the body being perfectly balanced, all its internal organs are rightly related to each other ; they have room to work harmoniously, and the result will be manifest, not only in increased beauty of outline, but in a better digestion, a brighter eye, a more glowing cheek, and a clearer mind.

DESCRIPTION OF ACCOMPANYING CUTS.[1]

Fig. 1. This is a good standing position, but if maintained any length of time is wearisome, as it keeps both legs in a state of muscular activity, whereas they should work alternately.

Fig. 2. Position in walking. Also good rest position as it can be maintained some time without fatigue.

Fig. 3. Gives a broad base and is therefore often assumed. Is not desirable, as it produces slight curvature of the spine, and makes the body unsymmetrical.

Fig. 4. Good sitting position. Should become habitual.

Fig. 5. A very bad attitude as it twists the spine.

Fig. 6. An improper position pushing the shoulders up.

Fig. 7. An improper attitude, as it makes the left side shorter than the right.

Fig. 8. Very bad position, cramping the chest, crowding the contents of the abdomen downward.

Fig. 9. Very bad attitude, strains the spine, and tends to produce permanent curvature.

[1] These cuts are from the *Educational Review*, by permission of Holt & Co.

Fig.1

Fig.2

Fig.3

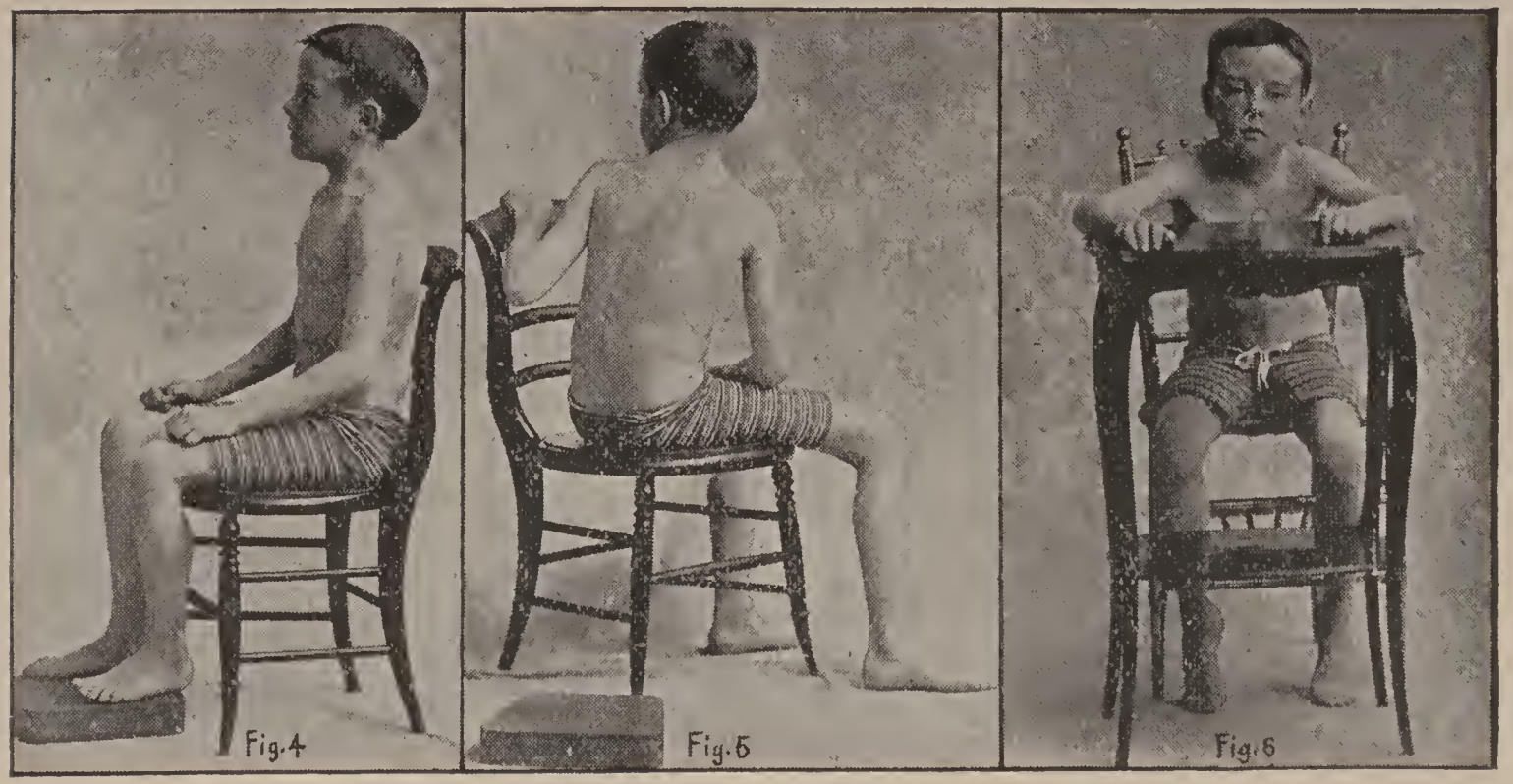


Fig. 4

Fig. 5

Fig. 6

Fig.7

Fig.8

Fig.9

CHAPTER IV.

THE PLUMBING.

A VERY important part of every house is the plumbing. In the walls, between the floors, and everywhere out of sight are water pipes, gas pipes, drainage pipes, electric wires, and speaking tubes. The health and comfort of the household depend upon the perfection of the plumber's work. Knowing that the divine Architect is all-wise, we would naturally expect the plumbing of our bodily dwelling to be perfect, and we are not disappointed. That is, it is created perfect, but we often let it get out of repair, and then we suffer. Perhaps we blame the Architect for this when we ourselves are at fault.

Minute tubes, some conveying fluid and nourishment and others carrying away waste material, pass through the muscular walls and even through the solid substance of the bones. The muscles are covered by a sheathing called the skin which is full of the tubes, so full that you cannot put down the point of a pin anywhere upon it without drawing blood. In the skin is

also a system of drainage pipes called sweat glands. They are very fine tubes, so short that ten of them, end to end, would only make an inch in length, and yet there are so many of them, all coiled up into knots, that if they were straightened out and laid end to end they would reach over four miles. There is something for you to think about.

In this chapter we learn only of the drainage pipes which are located in the skin, while the tubes that carry fluids to all parts of the body and those which act as drainage pipes to carry off waste matter from the interior, will be described in the various rooms to which they belong.

If a drop of water falls on a hot stove, it dries so quickly that we see no steam, but if we pour on a large quantity at once, we see the vapor, and know that the water is evaporated. When you run and get very warm, the sweat glands pour out water on the skin in large drops, but these glands are not idle even while we do not see the water on the surface of the body. They are at work all the time, but the water usually evaporates as soon as it reaches the surface. This we call insensible perspiration. It is all the time passing from the skin, and we are told that it amounts to nearly two pounds in

twenty-four hours. When we exercise, it is greatly increased and may amount to one pound in one hour. This waste of water from the surface of the body must be replaced by the water we drink, and that explains why we are so thirsty in hot weather or when we exercise. Heat causes these glands to throw out water rapidly, and the evaporation of the water carries off the heat of the body and keeps the temperature down to the normal point. If for any reason we cannot perspire in hot weather, or by means of exercise, we suffer greatly.

The perspiration is something besides water; it contains solid waste material, which, as the water evaporates, is left on the skin and stops up the little drainage tubes, unless we keep them open by frequent bathing. The little oil glands in the skin pour out a fatty secretion that dries on the surface, and the skin itself sheds little pieces of worn-out substance, which are caught in the perspiration as it dries, and cling to the surface. If we want the drainage of our bodily house to be faultless, we must keep these tubes open by the frequent use of soap and water.

A few practical suggestions as to taking care of the skin so that its waste-pipes may be kept in working order will not be amiss.

RULES FOR BATHING.

1. Never bathe sooner than two hours after a meal. To draw the blood to the surface of the body soon after eating interferes with digestion. Going in swimming soon after eating is especially dangerous, and a post-mortem examination of those who have lost their lives in this way reveals the fact that the pressure of the water forces the contents of the full stomach up into the esophagus and throat, and from there they are drawn into the trachea, causing suffocation. One should not eat under an hour after bathing.

2. Feeble persons should rest after bathing until the equilibrium of the circulation is restored. Those who are vigorous may exercise after a bath.

3. Never bathe when completely exhausted. A bath, to be beneficial, must be followed by complete reaction, and this is not possible when a person is fatigued.

4. The temperature of the bath-room is of importance, for, if too cold, it will require too much vitality to react. If the bath leaves the skin blue and cold, and the person shivers and cannot get warm for some hours, it has been an injury.

5. The hot bath should be followed by a quick application of cold water, so as to leave the skin in a tonic condition, thus lessening the danger of taking cold.

The time of day best suited for a bath must be decided by each individual's peculiarities, or by the circumstances of his life. Perhaps, theoretically, ten or eleven o'clock in the morning is the best time, but, practically, this is, for most people, a very inconvenient hour. Delicate people, perhaps, would do best to bathe just before going to bed. Vigorous people might bathe the first thing in the morning. Rubbing with olive oil, or cocoa butter after the bath keeps the skin smooth and supple, and acts also as a sort of covering to prevent taking cold.

Dry rubbing of the skin may also be employed in place of the bath. It will remove the dead scales of the scarf skin and keep the pores open. Owners of fine horses know how beneficial it is to have them well-groomed, but they often act as if they did not know that a well-groomed man is as much to be desired, not only out of consideration for the olfactory sense of others, but also for health, comfort, beauty, and the maintenance of self-respect.

CHAPTER V.

THE SHEATHING.

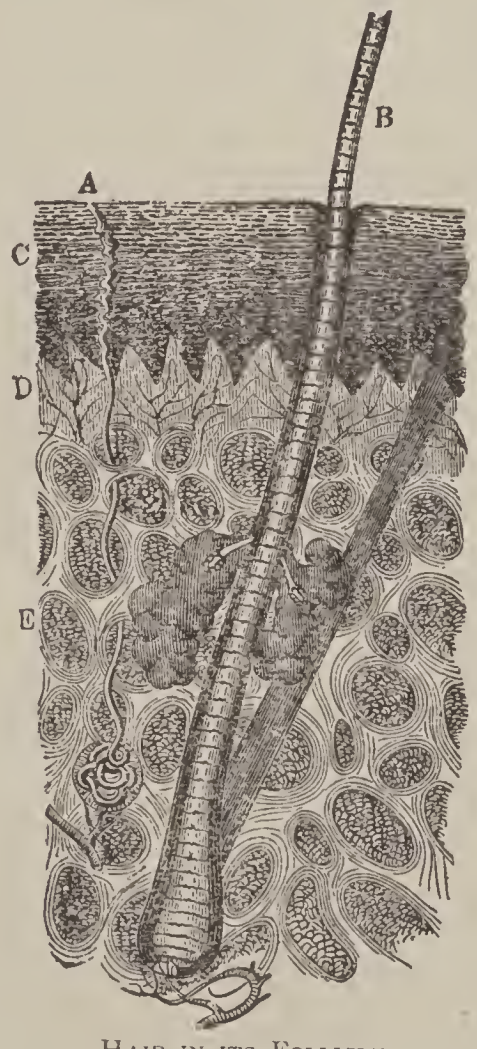
ACROSS the street I see men covering the outside of a new house. They first put on a layer of rough boards ; over these, a layer of felt paper ; then narrow boards, the lower edges of which overlap the boards beneath. This makes a tight, warm, water-proof protection to the rooms inside. Our bodily house must also have a protecting covering; but if it were nailed on, all the elaborate machinery made to move it about would be of no use. Just fancy how it would be if we were afraid of breaking to pieces if we ran about, or of pulling out the nails that fastened our siding on if we wanted to jump or climb. Our divine Architect makes no such mistakes.

The sheathing of our wonderful house is the skin, and the outer layer is formed of over-lapping pieces more like scales or shingles than siding. This is called the epidermis, or scarf skin. Beneath this is the dermis, or true skin, which is made of both muscular and elastic fibers,

filled in with fat. The dermis is the part through which run the plumbing tubes spoken of in the last chapter, and in it also are the ends of the electric wires that carry messages from the owner to all parts of the house.

In the building which the carpenters are covering with boards, the rough ones are put underneath and the smooth ones outside, and then a coat of paint is put on to give it a beautiful color. One peculiarity of the work of the divine Architect is that his work grows more and more beautiful the more closely and deeply we examine it. The outer covering is the coarse one, made as it is of horny scales that grow harder and harder as they are used, until, in places like the palm of the laborer's hand, they form what we call a callous. Under this course outside covering is the beautiful true skin, blushing with the bright color of the blood with which it is so richly supplied. The divine Architect does not paint the house on the outside, but in the lower layer of the upper skin is deposited a pigment which gives the house its hue. Some houses are a beautiful pink and white; in them there is little of the pigment or coloring matter. Others are yellow, others deep brown, and some are quite black; but, if the outer skin be removed, the true skin in each will be just alike.

The office of the skin is to protect the body, to keep it warm, to carry the plumbing tubes of the blood vessels, sweat glands, and electric wires of the nerves, and also the oil glands that keep it soft and smooth.



HAIR IN ITS FOLLICLE.

CHAPTER VI.

THE THATCH.

IN the old world, houses are often thatched with straw instead of being roofed with shingles, slate, or tin, and we may say that our house has a thatch, not of straw, but of hair. Little new houses have not much thatch, and in old houses the thatch is sometimes worn off, and then we say they are bald. Hairs grow from little pockets in the skin ; and, in fact, they are a continuation of the cells of the skin itself, carrying with them the same pigment that gives the skin its color. So we find that dark people have dark hair, and fair people have yellow or red hair. When no coloring matter is furnished, the hair becomes gray or even white. Into each hair pocket or follicle a little oil gland opens, so, you see, each separate hair has its own bottle of hair oil. If we keep the head clean and brush the hair well, we shall have no need of putting oil on it to make it smooth.

Each hair follicle has a nerve, and that is why it hurts when the hair is pulled. Cold air, or

water, or a sudden fright will make these nerves contract, and that makes the hair stand on end, as we say. That is illustrated when a cat sees a dog and bristles up all over. One of Job's friends says that he was frightened and his hair stood up. Read Job, 4th chapter, 15th verse.

Hair is very elastic, and will stretch a good deal before breaking. It is also very strong. A single hair has held a weight of two and a half ounces. Hair is found all over the body except on the palms of the hands and the soles of the feet.

The cells of the skin become hardened and form the nails, which protect the fingers and toes. If it were not for the finger-nails, we would find it difficult to untie knots, open pocket knives, and do many things we now do with ease. When we care for them, they also add to the beauty of the hand; but if not trimmed neatly and kept clean, they are indicative of a lack of true politeness.

A young girl was once putting on airs and attempting to pass herself off for a person of great importance, but another girl, who had been well brought up and trained to exquisite care of herself, recognized the lack of this, and exclaimed, "She's not a lady, look at her finger-nails!"

CHAPTER VII.

THE UPPER STORY, OR CUPOLA.

ON a short tower, called the neck, is found the most wonderful part of the house, the cupola, or head. It has a solid, dome-like, bony frame-work, covered with muscular walls, protected by the skin, and roofed with the hairy thatch. In its façade we have two windows — only two for the whole house, and yet they command a view in all directions because the cupola is so balanced that it can turn from side to side, or up, or down, and if we have need to look behind us, we have only to turn the whole house around. I once read of a man who built his house on the abandoned turn-table of a railroad, and when he wanted the sun to shine on any apartment, he had only to turn the house around. He thought that was a very fine contrivance, but, you see, that is what we all can do with our wonderful house, and we do it so often that we think nothing of it.

Over the windows is a little thatch of hair to keep the rain of perspiration from running down

into the eyes. Between the windows is a portico with two circular doorways, through which the good fairy Aura goes in and out. Below these is a pair of pink folding doors about which I shall have more to tell you. On the sides of the cupola are porticoes for the admission of sound. How seldom we think of the fact that Man knows nothing of the world except through the medium of his bodily house. If his windows are broken, he sees no more ; if his porticoes of sound are stopped up, he can hear nothing ; and yet, knowing this, he sometimes takes very little pains to keep his house in order. He will read by twilight, or on the cars, or strain his eyes needlessly just as if he was certain that he could go out and buy a new pair when these were gone. What we want to do is to learn about our bodily dwelling, so that we may know how to keep it in repair ; so we will go on to study our upper story, the general office of the establishment.

The contents of this upper story are so important and valuable that they must be well protected, and so the frame-work is very strong and solid, made of twenty-two bones, dovetailed together in a spherical form, as that is the strongest possible shape. Eight of these bones, made of three layers, form what is called the cranium, or brain case. The outside layer is

thick, tough, and somewhat elastic, so that quite hard blows do not break it. The inner layer is thin, hard, and brittle, so it is called the vitreous, or glassy table of the skull. This might break easily, but between it and the outer layer is a spongy tissue of bone which deadens blows. See how wonderfully all this is arranged to protect the brain. First, the arched or spherical shape made of several pieces, and then the three layers of bone with their elastic and spongy construction, and these mounted on the springy, flexible spinal column, all tending, as you see, to save the brain from jars, and make it safe for us to jump and climb and even receive falls and blows without serious injury.

We adorn the inner walls of our residences with beautiful paper, or paint them various tints. The inner wall of the cupola is covered with three membranes ; the one lying close to the inside of the skull is dense and fibrous, and is called the *dura mater*, the hard or durable mother. Inside of this is a very fine membrane called the *arachnoid.* There is a fable which tells of the Princess Arachne who was famed for spinning and was changed by Minerva into a spider. This membrane is called the *arachnoid* because it is so fine, like the cobweb for delicacy. The inner membrane is also fine and delicate and full

of blood vessels. It is called the *pia mater*, or soft mother. And what shall we find in this room so carefully prepared? Something wonderful and very precious, no doubt.

SURFACE OF THE CEREBRUM.

CHAPTER VIII.

THE GENERAL OFFICE.

THE apartment whose walls were described in the last chapter is called the cavity of the skull, and is occupied by a wonderful workshop known as the brain. A little boy was once asked if he could give the contents of the different cavities of the body. He said, "The cavity of the skull contains the brains, when there are any." We will take it for granted that all who are interested in the study of their bodily dwelling have skulls well stocked with brains, and will be interested in a description of this wonderful organ. Michelet, a French writer, calls it the "flower of flowers." That is very pretty, but, after all, does not give us much idea how it looks. If you could see the brain of a calf, or of some other animal, it would give you a very good idea of the brain of man. The meat of an English walnut, in its folds and wrinkles, is something like the brain. A large piece of paper can be crumpled into a small space; and if the wrinkles of the brain-substance were spread

out like a plain piece of paper, we should see that these folds have really given it a very large surface.

The brain is composed of two kinds of matter; one white, which forms the greater part of the interior, and the other gray, which spreads over the surface and dips down into all the folds or convolutions, as they are called. The depth of the convolutions seems to measure the intelligence of the individual. In a baby's brain the convolutions are very shallow, but as he becomes more and more intelligent, they grow deeper, so you see that skulls of the same size may both be full of brains, and yet one contain a great deal more brain than the other, because it is more deeply wrinkled, or convoluted. You must not be discouraged by the big words we have to use in the study of the brain, or get tired and say you do n't care to learn about it, because it is so uninteresting. Many things which, in the beginning, seem very dry, become very interesting to us after we have learned about them; and perhaps in the study of the brain we shall put an added wrinkle into our own brain-substance and be so much the brighter.

The brain is divided into the cerebrum, or great brain, and the cerebellum, or little brain, and each has its special work to do. It is always

this way in a well-ordered workshop. You will not find the workman doing one kind of work to-day in one part of the shop, and the same work to-morrow in another part. He has his bench and tools in one place, and does his work always there because it is much more convenient, and we shall find very much to interest us in the different kinds of work that are done in the different parts of the brain. The great brain occupies the upper and front part of the cavity of the skull, and the small brain, the lower and back part. The two brains are connected by a bridge called the *pons Varolii* because a man named Varolius first described it. Did you ever imagine that you had a bridge in your head? And what do you suppose passes back and forth upon it?

Brain looks not unlike a mass of dough in color, but is more like jelly in consistency. It is made of millions of little cells about which we shall learn when we study the servants of our wonderful house.

CHAPTER IX.

THE RECEPTION ROOM AND HALL.

BETWEEN the windows of our house is a porch with a sloping roof that covers two circular doorways. Below this is a pair of pink folding doors that open into the reception room. These doors are beautiful and have marvelous capabilities. They are closed by a muscle called a sphincter, which acts much like the puckering strings of our shopping bags. When drawn up tight, the doors are pulled into folds, and in this shape can make very pretty music called whistling. When stretched, they produce what is known as a smile; or, if the stretching is extreme, and we hear a loud "Ha! ha!" issuing from the doorway, we say that the man is laughing. That is the way Man has of letting it be known that he is greatly pleased. These doors also help him to make known his wishes, thoughts, and feelings, by means of spoken words, and these may be very pleasant or quite the contrary. We might almost call these doors curtains, for they are of soft muscle and have a bright pink

lining of mucous membrane. In some individuals, an ornamental lambrequin of hair is fastened above these doors. It is not only an ornament but acts as a guard to the circular doorways above.

We may as well learn right here that all the apartments of our bodily dwelling communicating with the outer world are lined with mucous membrane, which in its structure is quite like the skin, and unites with it at the opening into these rooms. At the edges of the lips we can see where this union takes place. The purpose of this membrane is to secrete a fluid which moistens the surface.

When the hands bring to the mouth any guests who desire to enter the house, the lips open to take them in, and, passing their folds, the guests are received by thirty-two attendants in a white uniform whose business it is to remove the wraps of visitors and make them fine enough to go on and visit the cook; for all who enter here are on their way to the kitchen. I said there were thirty-two attendants in white. There are not always thirty-two, and they are not always in white. Sometimes their uniforms have been sadly soiled and torn, and have been patched and the patching trimmed with gold — which does not add to its beauty, however.

In little new houses these attendants are altogether absent, but they are only asleep in their little pink cradles in the frame of the doorways called the jaws. There are only twenty of these, however, and for some months they lie still and sleep. Then they begin to be anxious to see the world and push their heads up so hard that they often make the baby cry. But they do n't seem to care for that, for they push away until one by one their little white crowns appear. Did I not tell you that they were royal attendants? O yes, they are, for each one wears a crown. For six or seven years these little servants stay, and then are crowded out by others who have lain in their cradles all this while, only waiting for the time to come for them to crowd their older brothers entirely out of the way and take their places, and now there are thirty-two of them, sixteen in each jaw.

In the center of each jaw are four sharp fellows called incisors, who investigate every visitor in a biting way, and pass him on to the rest, and they press him on all sides until, when they are through with him, he feels pretty well crushed. These latter attendants are called molars, or grinders, and you know them all as the teeth. Sometimes visitors on their way to the kitchen are so soft that they slip through

without much attention from the molars, but they are really not as well received by the cook as if they had been willing to be more thoroughly investigated. Then, too, it is no kindness to be sparing of the work of the molars, for they keep stronger and last longer if they have plenty of hard work to do. That is one peculiarity of our house. All of its workers keep in better health if they have plenty of the right kind of work to do.

I might suggest to you that these thirty-two servants, the teeth, need frequent bathing and scrubbing with a soft brush if you want them to keep in good health. When they are through with their work, they should have all dirt carefully removed, not only from the surface but from between them. They are such sturdy soldiers that they never break ranks, so you will have to clean them as they stand, solidly and closely together, and I would warn you to use them well and not to crack nuts, or to pull needles or nails with them (I have known people to do that), for this may injure their constitutions so that they break down all together, and then you will be in a sad plight, indeed.

These attendants do not do their full work until visitors have been judged by a guard in a pink uniform, who occupies a constant position in the reception room for the purpose of passing

his opinion on guests. This guard is chained to the floor so that he never can go away from home, but he sometimes puts his head out of the open door, though this is considered rather a breach of good manners. His name is Gustatory Sense, or Taste, as he is sometimes called for short. If those who enter here are pleasing to him, he allows them to receive the attention of the teeth; if not, he rejects them at once. However, he is not to be fully relied upon, for he sometimes becomes very fond of those who are injurious to the best interests of the house, and allows their entrance when he ought to put them out immediately. In this case he consults his own whims and fancies rather than the welfare of the house and its master.

Certain persons have the power of making every one feel at ease, and we find some such affable attendants in the reception room of our house. There are three closets called glands on each side of the reception room, making six in all, and from these issue Saliva, whose especial business it is to help guests along. Some folks, you know, are so stiff in their manners that we say they are "starched up," and Saliva pays especial attention to such, accompanying them all the way to the kitchen, and making them very sweet by changing their starch into sugar.

The roof of the reception room is arched or vaulted, and is called the hard palate. At the back of this room, which you know as the mouth, are two fleshy pillars, and between these is hung a pink *portière*, or curtain, called the uvula, or soft palate. This curtain answers a double purpose ; it divides the reception room from the hall, and it is also drawn up and back to close the passage into the nose when solids or liquids are passing down the throat.

We shall now talk of the throat as the hall of our wonderful house. It is a peculiar hall in that it has no floor. Seven passages lead out of it ; one into the mouth, two up into the nose, two into the ears, one to the lungs, and one to the stomach. We shall study each of these by and by. Now we will go with the guests across the hall or pharynx to the kitchen stairs, or esophagus, as it is called. These are peculiar stairs, about nine inches long, not quite straight, and with muscular walls which contract behind the descending substance and push it along. If it is a very small substance, these muscles have very hard work to squeeze it down, and that is why we may find it such hard work to swallow a small pill when we can easily swallow a mouthful of food.

CHAPTER X.

THE KITCHEN.

AT the bottom of the stairs we find ourselves at the top of the kitchen, and must jump down the rest of the way. This kitchen is a wonderful room, and when full is about one foot long and four inches broad. If you have ever studied in the kindergarten, I suppose you would call it irregularly conical in shape. This room, which is named stomach, has a strong wall of three coats, the outer one of fibrous tissue, called the serous coat, the inner, a mucous membrane, and between these a muscular coat whose fibers run in three directions — one set lengthwise, one around, and one obliquely. When these three sets of muscles contract, you can see how they draw the stomach into a smaller compass, and so churn the contents about. Here in this active, moving kitchen we find the cook, Gastric Juice, at work, cutting up the meat, peeling the vegetables, and breaking them into small pieces. He pays no attention to starch, but the saliva that accompanied starch

into the stomach still acts upon it. Oil is churned by the motion of the stomach, and so all the contents are thoroughly mingled.

In the walls of the kitchen are little depressions, which we may call cupboards, where Gastric Juice finds the substances he needs in his work. As the material for the nourishment and repair of the house is prepared in this room, it is quite important that we should understand its laws, for every part of our house is governed by laws which were laid down by the divine Architect himself. One of these laws is that food to be digested must be at blood heat. It is therefore injurious to drink large quantities of very cold water while we are eating ; for, as we may see, it puts out the kitchen fire, and so hinders the cook in his work. Ice water, too, by suddenly checking perspiration and chilling the body when heated, has caused death.

We can interfere with the work of the stomach by eating too much, for when the walls are greatly distended they cannot easily contract, and so stomach digestion is hindered. From three to five hours are needed to complete the work of the stomach, and to eat between meals gives the cook extra labor, and then, perhaps, he does nothing well. You can imagine how cross you would be if you had a cake half baked,

and some one should open the oven door and stir into it a quantity of raw material, even if it were the same as that of which the cake was made, and more angry still if it were raw apples or nuts or candy ; you ought, therefore, to be as thoughtful of your bodily cook as you would like others to be if you were cooking.

The exit from the kitchen is through an opening called the pylorus, which only allows food to pass out when thoroughly digested and keeps back all that is still undigested, so that it will be churned and mixed with the active substances of the gastric juice. This gate sometimes refuses to let things pass at all, in which case they may be sent hurriedly back up the stairs, through the hall and reception room, and cast out of the front door. This we call vomiting. It occurs when poisonous or hurtful materials are swallowed, or when the work of the cook has been for some time greatly interfered with by over-eating, or by eating unwholesome food.

Chemistry takes food to pieces and tells us that it is made of carbon, hydrogen, nitrogen, and oxygen. Man's body is made of the same elements, but we cannot live on them in that form ; we must have them made up into various combinations. Plants can take them in the raw state and make them over into themselves, then

we get them from the plants ; or other animals eat the plants and then we eat the animals. Some substances contain all these elements and are called proteids or, sometimes, albuminoids, because they are like albumen, or white of egg. Another substance containing all the elements is called gluten, and is found in grains. Still another is legumin, found in peas and beans. Casein is found in milk, and myosin, in muscle.

To obtain the right amount needed to keep the body in repair, we do not try to find some one substance containing all the elements, but we eat a variety of foods, such as bread, meat, eggs, milk, and fruits, so that the servants and general manager can select from the whole mass the things that are needed. We should not try to live wholly on starch and sweets which alone will not keep us alive.

All the foods we eat may be divided into albuminous, oleaginous or fatty, saccharine or that containing sugar, and amylaceous or starchy. We have seen that saliva digests starch, and that gastric juice acts on albuminoids and sugar ; but as yet we have found nothing that acts on fats. These oily guests come into our house and slip down into the kitchen where no notice is taken of them except to make them step around rather lively, until they come to have a much smaller

opinion of themselves than when they entered, and then they are allowed, with all the rest, to pass through the pylorus into the next apartment.

Water is also a very important food, both because the body is about three fourths water, and because water is being cast off constantly through the drainage tubes and must be replaced. As fruits are largely composed of water, they are valuable both as food and drink.

CHAPTER XI.

THE STORE-ROOM.

THE next room is sometimes called the second kitchen, but it has also a Latin name, *duodenum*, because it is as long as twelve fingers are broad. It is very narrow and curved like a horse-shoe, and its walls, like those of the stomach, are serous, muscular, and mucous. The food that has been broken up in the kitchen passes into the store-room ready to be further prepared for use, and here come two important assistants to help do the work. They are called Pancreatic Juice and Bile. Pancreatic Juice is said to be the most important helper in the preparation of foods for use in the house, though, like many other important people, he is seldom mentioned, and many have never heard of him. He is of a kindly nature and does not ask whether those who need his aid are rich or poor, but gives attention to all. He completes the work which Saliva began on the starch, and finishes on the albuminoids what Gastric Juice has left undone. He also acts on the oily substances,—splits them up, as it is said. Pancreatic Juice has

his home in a room called the pancreas. In animals it is called the sweet bread.

Bile comes from the liver, and after leaving his own especial room, the gall-bladder, he passes down a hall known as the common bile-duct into the store-room, where he joins in the work of preparing the food for use. It used to be thought that Bile was aristocratic, and that he only paid attention to those who had "struck oil," in other words, the fats, but we find now that he condescends to do other work. Indeed, we are told that he does not attend to fats perfectly without the aid of Pancreatic Juice. One of the offices of Bile is to prevent things from getting into that disturbed state known as putrefactive fermentation; that is, to keep them sweet and good. He also assists greatly in the taking up of the nutritious material by the little eaters of the dining room, known as absorbents, and he is also willing to help do the work of sweeping out the dining-room. So I think that we ought not to say that Bile is aristocratic, but should give him credit for all he does so willingly.

The walls of the store-room are fitted up with shelves made of folds of the mucous membrane, and this, you see, increases the surface. There are also many little cupboards, called glands, which secrete a fluid to be used in the work of digestion.

CHAPTER XII.

THE DINING-ROOM.

OPENING out of the store-room is the dining-room, a long, narrow apartment about an inch across but more than twenty feet in length. It has the same three coats as the kitchen and store-room. The first eight feet receives the name of the *jejunum*, a Latin word meaning empty, because it is usually found empty after death. The remainder is called the *ilium*, meaning twisted.

This long, narrow dining-room occupies the greater part of the second story of the house — the abdominal cavity; and, as this is comparatively a small place, the intestines must be folded and coiled to fit into it. They are not just twisted up and laid loosely in the abdominal cavity, but are held in place by a membrane called the mesentery. This membrane is as long as the intestines, but only about four inches broad. The intestines lie along one edge like the trimming on a ruffle, and the other edge is gathered, like a ruffle, into a length of six inches,

and this is fastened to the spine, thus holding the bowels in place and yet leaving them free. The internal lining of the intestines is in folds, making the same shelves as are found in the store-room, and for the same purpose of increasing the surface. Here, also, are glands secreting the fluid needed to complete the work of digestion. The head waiter is named Intestinal Juice, and he gives a general supervision to the completion of all processes of digestion and the preparation of food for absorption.

And who is to eat the dinner so elaborately prepared? O, the dining-room is always full of hungry little mouths ready to take in the food. They are never away riding a "safety" or playing lawn tennis; they never wait for the dinner bell to ring and then go scampering in with hair awry; they are always right there attending strictly to the business of eating. And such quiet, polite little eaters as they are. They never crowd each other nor scramble for the food, nor refuse to eat good bread and butter because they want cake. They are so small that as many as sixty of them are found in the one-hundredth part of a square inch.

When we were on ship board, we found our chairs were fastened to the floor, but in the dining-room of our bodily dwelling the little

The Parotid — One of the Salivary Glands.
Page 54.

Corpuscles of Human Blood, Highly Magnified. Page 77.

eaters themselves are fastened and cannot run away, so you may think that it is no particular credit to them that they are always found at home.

Under the microscope they look like little fine hairs, and give the walls a velvety appearance. They, too, have a Latin name; one is called a *villus*, and all are called *villi*, just as we say "Mr. Jones" when we speak of one, and the "Joneses" when we mean the whole family. How do you suppose the Joneses would feel if, when they came to breakfast, they should find that the meat and potato, and bread and milk, and fruits and coffee had all been pounded and ground and mixed together in one thin gruel-like mass (I am afraid they would say mess), and they could not say whether they would take eggs or oatmeal, or buckwheat cakes, or biscuit, but were just obliged to take the gruel and be satisfied. That is the way with the *villi*. They have no choice in the matter; they are obliged to obey St. Paul and "eat what is set before them, asking no questions."

Everything that has passed through the kitchen and store-room is mixed in a thin milky gruel, called chyle, and the villi work away sucking it in for dear life; yes, for our dear life, for they are eating that we may live. They are simply tak-

ing up this chyle, to pass it on, that it may go to build us up.

We know that the food we eat is made over into our bones and flesh and nerves; but how does it get into the blood so that it can be carried to the various parts of the body? The sugar that is digested in the stomach goes directly into the blood with the water, both being absorbed by the walls of the stomach. In the intestines, the villi suck up the milky chyle and gather it into a vessel called a lacteal, which is from the Latin word *lac*, meaning milk. These lacteals are held in the folds of the mesentery, and are connected by fine canals with other vessels called lymphatic glands, each of which is about as large as an almond. There is said to be about one hundred and fifty of them. They are spongy in structure, and when the lacteals pour their fluid contents into these lymphatic glands, you can understand how they take up the fluid as a sponge takes up water. After soaking through the glands and undergoing some changes, this fluid passes out through the canals into other lacteals, until it reaches a reservoir called the *receptaculum chyli*, or receptacle of chyle. One change that comes to the chyle while passing through the lymphatic glands is the power to coagulate, or form a clot. It also contains numerous white cells that it did not have before.

The receptacle for the chyle is at the lower end of a canal called the thoracic duct, which leads up through the floor of the thorax, through the third story of the house to the large vein at the base of the round tower of the neck, called the jugular vein. You see, therefore, that this system of lacteals, glands, and ducts is a part of the plumbing of the house, but it could not be described until we came to talk of the different rooms and their contents.

All through the various parts of the body, not only in the tissues of the vital organs, as the contents of the different cavities are called, but also in the appendages of the arms and legs, are vessels called lymphatics, and they are connected with the lymphatic glands, which are just like the lacteals and glands of the mesentery, and are therefore included in the plumbing. They carry a fluid called lymph.

And how is lymph made, and what is its use? This I will tell you in the chapter about the general manager.

We must not close this chapter without speaking of the colon, or large intestine, which may be called the scavenger box of our bodily dwelling, receiving, as it does, the waste material from the dining-room, and good housekeepers will know that it should be emptied at least once a day. It begins low down in the right side of

the abdominal cavity where the small intestine enters into it at right angles; not quite at its lower end, for below the place of union there is a little pouch known as the *cæcum*, one of a number of little closets of which much more is unknown than known.

The colon goes up the right side of the abdomen as far as the liver, there it turns and goes across to the left side, where it makes another turn and goes down to the outlet. It is altogether about six feet long and is much wider than the small intestine. By the peculiar arrangement of its muscular fibers the colon is in some places much smaller than in others, thus forming a series of pouches, so that any material that has passed from the small intestines into it is delayed until the nourishment remaining in it has been absorbed.

CHAPTER XIII.

THE FORCE-PUMP.

IN the very center of our bodily dwelling we have a strong force pump that sends fluids to all parts of the house. It is located in the third story, or thorax, and is so wonderful that I am sure we shall delight to study it. It is about as big as your fist and is conical in shape. It lies obliquely in the thorax with the base uppermost and toward the right, while the point touches the left side between the fifth and sixth ribs. A bright little boy who was asked where the heart was located exclaimed, "O I know. It is north of the stomach."

Put your chin down on your chest as low as you can; now place the wrist of your right hand on this point, with your finger tips about over the fifth rib on the left side, and you will see just about where the heart lies. "O," you say, "the heart cannot be away up there, for we feel it beat down on the side, and not at all up in the middle of the chest!" That is because the tip of the heart comes close to the walls of the thorax

and touches them at every beat, while the base lies back of the lungs and its beating cannot be felt, though it can be heard if you will listen at this point.

This little pump begins to work long before Aura comes rushing into the lungs, and it is the last organ of the body to stop working. In very small children it works very fast, perhaps making one hundred and thirty strokes a minute, but it gets over its hurry as people grow older, and in adults it usually beats about seventy-five times a minute; however, that differs in different people. If you put your finger on your wrist on the thumb side, you can feel the beating of the pulse, caused by the stroke of the heart sending the blood through the arteries.

The heart is a hollow muscle, but it is not like the muscles on the outside of the body. These are controlled by the will, but we have not been given control of the beating of the heart. And that is a fine thing for us, for if we had to manage it all the time, we should be able to do little else. We could not go to bed, as we do now, and sleep soundly, feeling sure that this little force-pump would work away all night just as it had worked all day. Does it never rest, then? O yes, it rests between beats. It makes a stroke, and then it rests, then it beats again,

and so it keeps on from the first moment of life to its end. It does not get much rest, does it? and yet I think it rests more than you may imagine. It is calculated that it rests about two-fifths of the time, which really makes about nine hours in twenty-four.

I think you will be surprised to learn what a vast amount of work the heart does. As I said, it is a hollow muscle, and is divided into two parts, a right and left heart, as we say. Now, do n't tell somebody that I said we have a heart on the right side, and another on the left side, for that is not true. We have a right and a left heart, but both are enclosed in a sac, the *pericardium*, which means around the heart. Each division is again divided; the upper part on each side is called the auricle, and the lower one, the ventricle. The right and left sides of the heart are entirely separate from each other with no door of communication between, but the auricle of each side is connected with the ventricle of the same side by an opening, and this opening is closed by gates called valves, which are really folds of the membrane lining the heart. These gates swing from the auricles into the ventricles, but never the other way because fleshy strings are fastened to them that let them swing only until their points come together, thus en-

tirely closing the opening. Some physiologists maintain that these valves act as a sort of hollow piston to push the blood along, and this is another reason why we may call the heart a force-pump.

But how much work is done by the heart in twenty-four hours? Physiologists differ in their calculations; but if we suppose each side of the heart holds six ounces, and the beats are seventy in a minute, we can come pretty near finding out what it does. Supposing you work at that problem and see if the heart does not move about eighteen tons of blood in a day. But if it moves eighteen tons a day, that does not accurately measure the force it uses, for we must multiply the weight by the distance it is lifted. If we say we lift one pound one foot high, we know just exactly what we do, and we call this a foot-pound. If we lift four pounds four feet high, it is the same as lifting one pound sixteen feet high, or sixteen pounds one foot high, and so we call it sixteen foot-pounds. At every beat of the heart six ounces are sent from the left ventricle into the large artery called the aorta. If there were no walls to confine it, we are told that the blood would jet six feet high at each stroke, so you see that at each heart beat, enough force is used to send six ounces six feet

high ; or, to put it the other way, it could send thirty-six ounces one foot high or one ounce thirty-six feet high. Thirty-six ounces are two and a quarter pounds, so, saying the heart beats seventy times a minute, we multiply two and a quarter by seventy, and find that force enough is used to send one hundred and fifty-seven and a half pounds one foot high, or one pound one hundred and fifty-seven and a half feet high. Now go on with the problem. Multiply one hundred and fifty-seven and a half by sixty minutes in the hour, and that by twenty-four, the hours in a day, and the result is 226,800 foot-pounds lifted by the left ventricle alone.

The walls of the left ventricle are thicker and stronger than those of the right, because it must send blood to all parts of the body, while the right ventricle only sends it to the lungs. A rough estimate of the work of both ventricles together would make the heart use as much force each day as would lift a man weighing 150 pounds 2000 feet or nearly half a mile into the air. What a marvelous little force-pump the heart is ! Should we not use it well and give it time to rest ? Count your pulse when you are lying down, and then when sitting up, then when standing, then after you have been running, and you will understand why the heart will

rest much faster when you are lying down. We need to exercise, to make the heart send the blood vigorously to all parts of the body, and then we need to lie down and sleep that it may have time to rest and gain strength for a new day.

CHAPTER XIV.

THE GENERAL MANAGER.

I FANCY your father would think he had made a fine bargain if, when he bought a house, he should be told that all he would need to do to keep it in repair would be to bring the mortar, glass, nails, wood, and other materials, and the house would help itself to all that was necessary. In truth, that is all we have to do to keep our bodily house in good order. We cannot furnish the glass but we must furnish the material out of which glass is made. We do not furnish bone but the material from which bone can be made, and so it is with every part of the house. And if we do not furnish the right kind of material in the right quantity, the house falls into decay, or goes out of repair, and this we call being sick.

In our homes there is usually some one who superintends the housekeeping. Have we no such general manager in our bodily dwelling?—O yes, indeed. Her name is Blood, and a very active, busy little worker she is, if we give her half a chance. She goes about the house day

and night, never stopping, but seeing that everything is put in order. If I were to paint her picture it would be as a jolly, round little body, with a scarlet dress, and a white cap on her head.

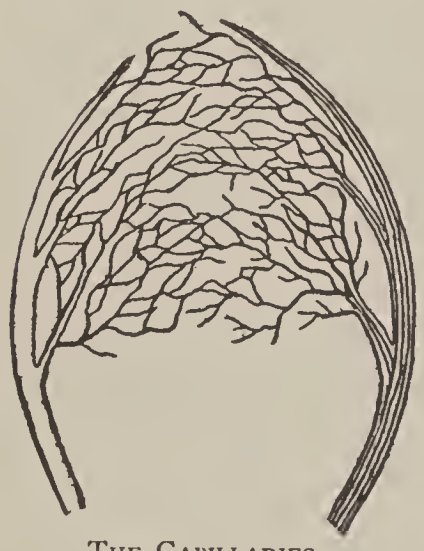
A large passage called the aorta leads from the left side of the heart, and this divides and subdivides into many small halls, called arteries, and these into still smaller ones, called arterioles, and these again into some so small that they are known as capillaries, a word meaning hairs. These capillaries are found in every part and every organ of the body. When we stick a pin into the skin, and it bleeds, it is because we have pierced a capillary. These capillaries are gathered up in the larger vessels or tubes, called veins, and these into still larger ones, until at last two large veins, the *vena cavae ascendens* and the *vena cavae descendens*, enter the right side of the heart.

The arteries carry pure blood and may be likened to water pipes. The veins carry impure blood and are, therefore, like drainage pipes. So you see the arteries and veins belong to the plumbing of the house; and as it is through them that blood goes to all parts of the body, we could not very well describe them until we came to talk of our general manager.

The blood is composed of cells or corpuscles, some red and some white, about one white one to six hundred red ones, and that is why I said the dress of the housekeeper was red and her cap was white. These corpuscles float in a watery fluid called serum, and in shape are like pieces of money hollowed out on both sides. They seem to be alive, and find their way in crowds through the arteries down into the tiny capillaries where they have to go in single file. These corpuscles carry the oxygen and all the material needed to build up the body, and when they go into the capillaries, they slip through the walls, one by one, into the tissues and there give up the food they have brought. The dead, or waste matter, slips through the walls into the blood, then it is carried to the heart by the veins, and from here the blood goes to the lungs where it is cleansed, as we learned in reading of the laundry; and goes back to the left heart and starts out again on its round through the body, and this is the way our bodily housekeeping is done.

Blood carries with her a peculiar substance called *fibrin* which prevents her running away. It might almost be called her conscience. You know that sometimes when you are tempted to do a wrong, there is something in you that stops you. Perhaps you think you will play truant,

but this invisible something seems to tie your feet and you cannot go. We call this conscience. The fibrin of the blood is that substance which forms a *clot*. You have perhaps seen a clot of blood, but have not thought how important it is that blood should clot, or coagulate, as it is called. If freshly drawn blood is whipped with twigs, we can see in it little fine white threads. This is the fibrin, and is what makes a wound stop bleeding of its own accord, by catching the red corpuscles and forming the clot. It is just as if Blood carried strings in her pocket, and when she finds a temptation to run away through an open door, she ties her own feet so she cannot go.



THE CAPILLARIES.

You will readily understand that Blood never rests. Night and day she hastens on her round of duties. She starts out rather briskly impelled by the force of the heart, perhaps at the rate of ten or twelve inches per second, but in the capillaries she does not go faster than one inch a minute, for here it is that the real work of the housekeeping is done, and she must go more

slowly in order to attend to business. When she gets to the veins, she finds little gates or valves that shut behind her and prevent her going back even if she wanted to. Here she cannot feel the impulse of the heart so strongly to hurry her along, and if she is away down in the feet, she has a long distance to climb; but the valves close behind her, and if we are exercising, the muscles press upon the veins and hurry her along. The action of the lungs in breathing gives her a new impulse, and the suction of the right auricle after it empties itself into the right ventricle, calls her forward, and so Blood is impelled through the veins to the heart. Sometimes, Blood gets very much excited because some enemy has come into the house which she is very anxious to get rid of, and she rushes through the halls very fast, and gets everything stirred up into a great state of excitement which we call a fever; and unless something is done to make her cool down and move a little more gently, Man may actually be compelled to move out of his house and leave it.

CHAPTER XV.

THE SERVANTS.

WE may, in a general way, call the hands and feet servants, but they are only automatic servants obeying Man's will as machines; we will therefore think of them only as appendages. Did you never wish that a dish-washing machine could be invented? Well, you see that in your hands you have a most complete one. Nothing could be made so perfectly adapted to its various uses as the human hand with its bony framework, muscular machinery, and electric wires of the nerves. Man is the animal with the thumb, and the possession of that little organ gives him great superiority. Experiment, and see how few things you could do well if you had no thumb, and you will come to prize that part of your hand more than you have ever done before.

But we are now going to talk of the servants of our bodily dwelling. The principal servants are the cells, and marvelous little creatures they are. Cells are little sacs containing a jelly-like fluid which looks much like the white of an egg;

they are so very small that over three thousand of them could be laid side by side in the space of an inch. There are bone cells, nerve cells, muscle cells, brain cells, and blood cells. These have the power of changing their form, of selecting their own food out of the general mass, and each particular cell understands and does its own peculiar work. Activity of the body, speech, thought, or feeling, changes or destroys cells, but, in a very strange way, the destroyed cells appoint, or rather create successors exactly like themselves, so that while we are continually dying, we are continually being made over anew.

You may call these cells, then, general servants, each having a certain line of work to do, and doing the work always as perfectly as possible with the materials furnished. The general manager, Blood, brings material to the tissues, and the bone-cells select from it the different forms of lime, magnesia, and soda that are needed to build up the bones and keep them in good order, while from the same store of material the muscles and the nerves search for the albumen, glycogen, and other material which they need. Each cell has its own time to die. Some, as in the intestines, live only from twelve to twenty-four hours ; others, as those of the bones, may

live for years. You see, then, that where they have the most work to do, they die soonest.

Cells are constantly busy with different kinds of work. First, we may say their work is to absorb nutrient material, each tissue searching out that which it especially needs. Second, their work is to make that material over into some part of the body, but, of course, in putting in new material in any part of the body, the dead material must be removed, and so, third, a part of cell work is to separate waste matter that is of no further use and cast it out, just as the workmen gather up the pieces of lime and mortar or broken glass after they have done a job of repairing. Fourth, cell work is to increase the size of the organs. In people who have their growth, the cells have only to remove the worn-out matter and put in new; but children are growing all the time, so, in them, the cells must be continually adding new material.

All over the body these tiny, living cells are busy, busy; the liver cells are making bile, liver sugar, and separating waste matter; the cells of the glands are making saliva, gastric juice, and other digestive fluids, and other cells are making the coloring matter that paints our skin.

If the body is injured, the cells at the border of the wound go to work to heal it by filling up

the space with new material. We talk sometimes about salves and ointments having healing power, but the healing power really lies in the ability of the cells to make new tissue.

Cells are often very kind and helpful and will undertake to work for each other. Thus, if the skin has been chilled, the mucous membrane will try to do the work for it, and that is why there is such an increase of mucus in the nose or bronchial tubes when we have a cold. If the kidneys do not work well, the skin tries to help throw out the waste matter, and so we find all over the house the various servants are kindly helping each other, for they are all related, and they seem to know that if any are sick they will all soon suffer.

In the study of the dining-room we learned how the food was carried into the blood, and now we learn how and why blood is carried everywhere throughout the body. You remember that blood can open a door at any point along the walls of the blood vessels and slip into the tissues. No doubt more blood will pass into the tissues than they need, and this excess must be removed, so we look for the machinery that is to remove it, and we find it in the system of lymphatic glands and vessels that we talked about a little when learning of the lacteals.

These lymphatics take up the excess of blood, and with it any waste material that it has picked up. This forms what is called lymph, and it is worked over in the lymphatic glands so it can be used again. Our divine Architect teaches us a lesson in economy; nothing is wasted, but everything that can be of service is made over and is used again. I have seen people who seemed to think it an evidence of greatness to be extravagant, but after all, in spite of themselves, they were making over material and using it a second time in their bodily dwelling. I wonder if they would have thought less of themselves if they had known how busy the lymphatics were, gathering up the remnants and making new blood out of them. It seems to me that if God, who has all resources at his command, can think of economy in his work, we ought to be proud to economize, and boast rather of what we save than of what we spend.

CHAPTER XVI.

THE PURIFYING APPARATUS.

BETWEEN the windows of the eyes begins the sloping roof of the porch we call the nose, covering the two circular doorways through which the good fairy Aura goes in and out of the house. This porch has a bony, cartilaginous framework and muscular walls. Its interior is divided into two passages called the nasal *fossæ*. These passages, like all cavities opening to the air, are lined with mucous membrane which secretes the semi-fluid called mucus. It used to be thought that this mucus in the nose came from the brain, but a man named Schneider discovered that it was made by this membrane, and it is therefore called the *Schneiderian* membrane.

Aura mounts the dark stairway, not hindered by the hairy guards stationed there to keep out intruders; she descends through the winding passages into the hall of the pharynx, and, crossing the head of the kitchen stairs, she lifts the little trap-door called the *epiglottis* and goes

down another stairway, the trachea, into the laundry, or lungs, which occupy the larger part of the third story of the house, known as the thorax. This stairway of the trachea differs from that which leads down into the kitchen in the fact that the walls are firm and do not lie close together as do the walls of the esophagus.

The trachea, sometimes called the wind-pipe, is about four and a half inches long. At the top of it is the wonderful musical instrument, the larynx, through which Aura gently passes, usually making no noise. At the bottom of the trachea two passages branch out to the right and left. These are called the bronchial tubes. They divide and subdivide into still smaller tubes until they become exceedingly fine, but still Aura finds her way through them to the place where each ends in a small room known as a pulmonary lobule, where are placed the stationary tubs or air cells.

Here it is that the most wonderful washing process takes place, the washing of the blood by the air. We may perhaps think that if Aura is a fairy she will not do such menial work as washing, but that which she does is like the wonderful stories we read, where the fairy waves a wand and says, "*abracadabra, presto change,*" and all is done.

Monday is often spoken of as the day when there are "picked up" dinners, and all sorts of discomforts. In some parts of the old world, washing-day comes once in three months among the poorer people, and once a year among the rich, and then a great ado is raised. Numbers of washer-women are called in, big fires are built, and there is a rubbing and scrubbing that goes on for a week before all the soiled clothes that have accumulated during the year are cleansed.

But every day is wash-day in our bodily-dwelling, and if the other business of the house were much disturbed by the process, we should be in "hot water," or "suds" all the time. But in truth the work goes on so quietly and systematically that we think little about it, although we become much distressed if, for any reason, Aura is interfered with in her work. In order to understand what she does, we will have to learn a little more about the structure and purpose of the lungs. First let me point out to you that the trachea is made with firm walls, but the rings of cartilage do not go all the way around, for if they did they might interfere with the working of the esophagus, and prevent the food from passing down into the stomach; so, just at the back, where the esophagus and trachea

lie together, the cartilaginous rings of the trachea are finished by muscular fibers.

The walls of the bronchial tubes are stiffened with cartilage so that they will stay open. All these passages are lined with mucous membrane, and here are stationed very fine and delicate attendants called *cilia*, who keep up a constant bowing motion toward the trachea, and so help Aura to get back again to the outer world.

The bronchial tubes and the air cells make up the lungs, hung like two air bags in the cavity of the thorax. This cavity is lined with a membrane called the *pleura* which is reflected back and covers the lungs. This membrane secretes a fluid that makes the lungs move easily as the two coats of the pleura play upon each other in breathing.

You have not forgotten that the thorax is framed with the spine and sternum connected by the ribs, twelve on each side. These ribs are so attached to the spine and sternum that they are to quite a degree movable, and the strong muscles are so arranged as to lift them upward and outward at each breath. When those lift, the cavity of the chest grows larger, and this is an invitation to Aura to come in and fill the space, which she quietly does. But the cavity is enlarged not only from side to side, but from above and downward.

The floor of the thorax is a strong, muscular partition that acts also as a roof or ceiling to the abdominal cavity. There are openings through it for the kitchen stairs and for some of the plumbing and electric wires, but it closes tightly around these so that there are no open spaces in it. This muscular partition is called the diaphragm, and it is a very important breathing muscle. The floor formed by it is like a dome swelling up into the thorax. It is fastened along the lower border of the ribs, thus making the front side shorter than the back. When we breathe in, it flattens or grows "taut," as a sailor would say, and the sides push outward. When we breathe out it relaxes and rises in the centre and the sides come in. An idea of the movements of the diaphragm may be obtained by opening and shutting an umbrella. When you open the umbrella, its diameter increases and the silk is tightly stretched. When you partly close it, the diameter is shortened and the silk is loose. If you had an elastic cylinder around the umbrella, you see it would need to stretch a good deal as the umbrella opens. The body is an elastic cylinder around the diaphragm and naturally stretches when breath is taken in, and the diaphragm grows tense and spreads.

If tight clothing is worn, the body cannot stretch, and the action of the diaphragm is inter-

fered with, the lungs are not completely filled with air, and serious results follow. In this case, the lungs trying to take in all the air possible, make great effort. The upper muscles of the thorax work harder to lift the ribs further, and we have a great heaving of the chest. Some people have supposed that because women breathe in this way it is proof that this is a feminine style of breathing, but, in truth, it is only an effort to take air into the lungs that are so compressed by bands or tight clothing that they cannot expand at the lower part as they should. It has been learned that a man dressed in the same way will breathe with the upper part of his chest, in the so-called feminine fashion.

We sometimes hear women say that they cannot sit up unless they have on corsets to support them. If we should see a person putting an iron band around his dwelling, and he should tell us that it would not stand up without this band, we should at once say that he must have employed a very poor builder, but we know that our divine Architect does not do such poor work; and if the bodily house cannot stand erect without stays, it is because the muscular walls have not been used, and thereby have become weak. Now that girls are using their muscles, we find

that they, like boys, can grow up with firm walls that will hold them up without external aid.

But some people have an idea that the body is not so beautiful if left as the Creator made it, as when it is made over and drawn in to give a slender effect. If we take a peep inside and see what is done to the internal organs, I think we shall come to have a different idea of beauty. We are not fond of tiny rooms in our dwellings; we don't like to have the furniture all crowded so closely together that we can hardly walk through. We never hear people boast of how small a house they have, unless it is their bodily house they are talking of; and then they sometimes like to tell how they can squeeze it into the smallest possible compass just over the rooms that contain the most precious furniture. The lower part of the laundry is thus compressed so that Aura cannot get in, the working of the force-pump of the heart is hindered, the kitchen is squeezed so that it cannot churn the food properly, and the furnace and sugar manufactory of the liver is pressed quite out of place; and perhaps, worst of all, the dining room is pressed down out of the proper place in the abdominal cavity until it rests upon the contents of the pelvic cavity, thus creating a great deal of pain and trouble.

Is it not queer that women, who are such excellent housekeepers and who are so distressed if their dwellings are out of order, should so persist in disarranging the furniture of their bodily houses and claim that it adds to their beauty? I think, however, that it is because they have not studied the construction of their own bodies. I am sure that you who know about the marvels of yourself and the work that is being done in your body, will not interfere with the efforts of the kind servants who work night and day to keep you alive, by making them live and labor in a room so small and restricted that they cannot do their work well.

In order that you may understand the wonderful washing that goes on in the laundry, we shall have to study about the changes that take place in the blood that make it need cleansing. I have told you that we are constantly dying, and one office of the blood is to gather up the little dead particles that result from all the activities of life. These dead atoms exist in a form called carbonic acid gas, and are produced by a waste of the tissues; the blood also brings back to the tissues that which will replace what they have lost, and this is another gas called oxygen. The blood comes into the lungs dark and impure; it gives up its impurities, and by the action of

oxygen is changed from its dark color to a bright scarlet. This is the washing process. There is no rubbing and boiling and rinsing and starching, and, after the washing is done, no scrubbing to do. The blood runs through minute channels in the membrane of the air cells, and the air fills the cells on the other side of the membrane. The carbonic acid gas slips through the membrane from the blood into the air, and the oxygen slips through the membrane from the air into the blood, and the washing is done.

Eighteen or twenty times a minute Aura comes in bringing in the supplies of oxygen and goes out with the carbonic acid gas, and the more deeply we breathe, the more perfect will be the cleansing of the blood.

Dr. J. H. Kellogg says that every time we breathe we spoil at least a half barrel of air, or six hundred barrels every hour. This gives us a very good idea of how needful it is to have some way of letting pure air into the rooms we inhabit. If every door and window is tightly closed, and the fire and lights are burning, using up our oxygen as they must in order to burn, we cannot wonder if we have a headache, and feel stupid, for we are poisoned by breathing in the waste matter from our own lungs, because we are not taking in oxygen to give us new material. Tracy says

that a five-foot gas burner creates as much carbonic acid gas as five men.

When we say that we spoil one half barrel of air at every breath we, of course, do not mean that we breathe out that much, for the lungs do not hold more than one and a half gallons of air, and we do not empty them fully at each breath. About two-thirds of a pint of air is taken in and breathed out in moderate breathing, and this we call tidal air because it ebbs and flows like the tide. When we run or exercise briskly the heart beats faster, the lungs work harder, and we take in more air, five times as much, perhaps, and this is called complemental air. When we breathe out this fuller amount, it is called reserve air, because we had it reserved for some special occasion which demands more than the ordinary tidal air. But after we have breathed out all that we possibly can, there still remains as much more that we can by no means empty out of the lungs, and this is called residual air. Residual means that which remains, so we can see why it gets that name.

The question may arise in your minds, how can oxygen get to the little tubs of the air cells to wash the blood, if not more than one tenth of the air is changed at every breath? I will see if I can explain that. You see that the air going

out of the lungs is not like people going out of a room, where those near the door must go out first before those at the further side of the room can go out. To explain the change of air in breathing we must study the law of diffusion of gases. That sounds as if it might be very hard to learn, but like many other things it is much easier than you might think. Gases are very light substances, lighter than air. Indeed, air is made of gases, oxygen one part, nitrogen four parts, with a small amount of carbonic acid gas. The gases are all very friendly and mix readily with each other, until the same amount of each is found in every part of the vessel containing them.

The air which comes into the lungs has a large amount of oxygen, and that which remains in the lungs has quite an amount of carbonic acid gas, which it has taken from the blood. The air that is breathed out has less oxygen and more carbonic acid gas. As the air was breathed in, the gases began to mingle all through the lungs until they were equally distributed, and then the oxygen that was near the walls of the air cells passed through them into the blood, and so we see that although the lungs are never entirely emptied, yet the whole volume of air is changed at each breath.

The walls of the air cells are so thin that ten of them would not be thicker than this paper; and if all that are contained in one pair of lungs could be spread out over a flat surface, it would cover a space equal to 150 by 160 feet. You see there are about 600,000,000 of these little tubs in our laundry, and each one made of this delicate membrane, so we can get an idea of the amount of washing done at each breath.

But if we send out so much carbonic acid gas at each breath, how does the outside air keep pure? Because the trees and plants take up the carbonic acid gas and give out oxygen, and so they purify the air which we pollute. That is why the air of the country seems so sweet and pure, and why plants and "green things growing" are so necessary in cities. Little parks in the midst of great cities are not only a beauty but a need, and plants in houses help to purify the air as well as to make the home look bright.

CHAPTER XVII.

THE HEATING APPARATUS.

THERE are many remarkable things about the body, as you have already learned; but I have one more marvel to tell you now, and it is that no matter how cold or how hot the weather, our bodily temperature remains about the same, and we begin to ask, Where are the stoves that keep it warm?

Some dwellings are heated by hot air from a furnace, others by steam, others by natural gas, or wood, or coal burned in stoves or open grates. Our wonderful house has a combination of methods. We all know that a fire will not burn unless it has air. In the process of burning, the oxygen of the air unites with the carbon of the fuel. This is called oxidation, and by it carbonic acid gas and other products are formed. Again we find our good fairy Aura with her assistant, Oxygen, helping to keep us warm. Oxidation is a chemical process, and chemical processes are always accompanied with the formation of heat. Foods, as we have seen, consist of

carbon, hydrogen, nitrogen, and oxygen. These are taken into the body and undergo a process by which the carbon and hydrogen unite to form carbonic acid gas, and the hydrogen and oxygen unite to form water. This process is called oxidation of the tissues; and, as it goes on in every cell, we may call the cells little stoves.

In our study of the lungs we learned that oxygen is taken in and carbonic acid gas given out at every breath, and this process keeps up the fires all over the body in these little cell stoves. We might almost call the lungs and the pores the stove-pipes which carry off the smoke and bad gases. The greater the quantity of the food that is assimilated, the greater the amount of carbonic acid gas thrown off. The more a man exercises the more the cells will have to do to repair waste, so we learn how exercise makes us warm, since it causes the cells to work harder, to die sooner, and to demand more new material through the food for repair, and this demand we call hunger.

We can also understand why we are cold when we sit still. We do not take enough oxygen in the lungs to feed the stoves, and the lungs do not carry out the waste material very fast; the cells, not being called on to work very fast, do not generate much heat. They live longer but they are only half alive.

If exercise produces heat, we can readily understand that active muscles are great sources of heat production. By pressure on the blood vessels they increase circulation, and this brings more oxygen to the tissues. Exercise uses up the tissue cells and they call for new material from the blood, so you see heat is created by this process of decomposition or combustion, as we may call it. Physiologists estimate that four fifths of the heat of the healthy body is produced by the muscles. If you are cold and are sitting still you can know that the fire in your cell stoves has died down very low, and the quickest way to rekindle it is to exercise briskly. Get up, shake your hands and feet, run, jump, and call the general manager, Blood, to go rapidly through the house and look after the fire, rake out the cinders and ashes, and bring new fuel, and soon the pipes of the lungs will carry out the deadly gases, and Oxygen comes in and starts the fire to burning brightly. If the temperature is raised by exercise, it will not fall under an hour and a half, so we can understand that to sit still longer than that period of time will probably result in a slowing of the circulation that will make us feel cold.

Digestion is a chemical process, so we will not be surprised to learn that it produces heat.

L. of C.

Some particular kinds of food produce more heat than others, and these are the foods in which there is a superabundance of carbon.

I told you that the blood slips through the walls of the blood vessels into the tissues, and waste material passes from the tissues through the walls into the blood, and also that the oxygen goes through the membranes. This is called *osmosis*, the passage of fluids or gases through animal membrane. When the blood goes into the tissues, it is called *endosmosis;* the waste material goes out of the tissues to the blood, and this is called *exosmosis*. This process is accompanied with the formation of heat.

Glands are organs that take material from the blood and make out of it new material, so the gland cells are also stoves. Mental exertion produces heat. The brain of a man that is thinking is warmer than that of a man that is sleeping, so the brain cells are stoves too. The liver is the largest gland of the body, and in its work a large amount of heat is produced so we may call the liver a furnace. It does various kinds of work. It manufactures sugar and glycogen, and one always needs a fire in a manufactory, you know. It excretes waste matters and secretes bile, and these processes are chemical and produce heat, so we need not be sur-

prised to learn that the liver is the warmest part of the body.

Perhaps it would be well to tell you just here the difference between excretion and secretion. Excretion is taking material from the blood and casting it out of the body unchanged. The kidneys are excretory organs. Secretion is taking material from the blood and making out of it a new material. The liver is both an excretory and a secretory organ.

Do you ask if clothes do not make us warm? I answer that they keep us warm but they make no heat. They only retain the heat which our body makes, and the poorer conductors of heat they are, the better they will keep us warm. Linen is a very good conductor of heat and takes it away from the body so fast that it is not a very good article of clothing. Cotton is not so good a conductor as linen, but better than woolen, so cotton does not keep us as warm as woolen.

Our bodily temperature is about 98 degrees Fahrenheit (that means by the thermometer invented by a man named Fahrenheit), though it varies somewhat during the day. As we eat and exercise, the temperature of the body rises and reaches its greatest height between five and eight in the evening. While we are quietly sleeping

it falls, and is lowest from two to six in the morning. If we sleep in the day and work in the night, this will be reversed. The skin is the regulator of temperature; if we get too warm, all the little doors of the skin are opened, and water is poured out on the surface to cool us off.

THE SKIN AND ITS PLUMBING.

CHAPTER XVIII.

THE LABORATORY, MANUFACTORY, AND STORE-HOUSE.

A CHEMIST is one who analyzes substances, or takes them to pieces and finds out of what they are made. He learns that the human body contains iron, soda, potash, albumen, and a great variety of other substances ; and then he takes all of these substances to pieces and finds that they are made of oxygen, hydrogen, nitrogen, and carbon put together in various proportions. For example : two parts of hydrogen and one of oxygen form water ; nearly four of nitrogen and one of oxygen form common air.

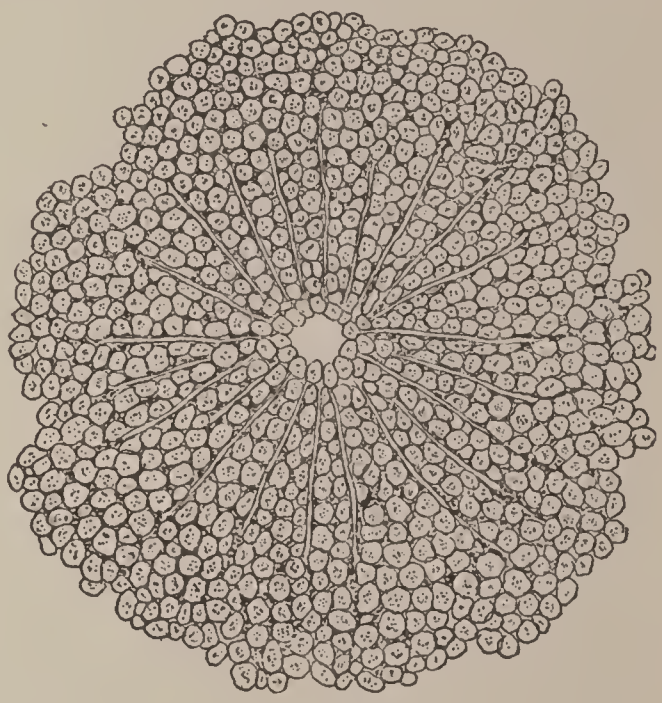
The work of the chemist is done in a room called a laboratory. He does not find it difficult to take things to pieces, and he can unite many substances and form new ones ; but he has not yet learned how to give life to the substances which he forms. He may take of the elements of the human body in the right proportion and put them together, and yet he will not have

a living body. There are vital processes as well as chemical processes.

We know that chemical changes are going on in all parts of the body all the time, so that the whole body might truly be called a laboratory, but I have given the name in this chapter to one especial organ which combines in itself a chemical laboratory, manufactory, and a store-house. This organ is known as the liver. It is the largest organ in the body, lies on the right side, close up under the diaphragm, and fastened to it by ligaments, so that it rises and falls with every movement of the diaphragm in breathing. Wonderful work goes on in this organ, but before speaking of it more particularly, I shall be obliged to tell you something about the portal circulation.

In the chapter on the General Manager, we saw how Blood started from the left side of the heart and found her way into the farthest extremities. All the blood does not go down to the feet, but some of it takes a short cut across to the liver through a union of the intestinal blood vessels, forming what is called the portal circulation. Through this some products of digestion go directly to the liver and pass through certain changes before being thrown into the circulation. A piece of liver has no great beauty until we come to examine it under the microscope,

then we find much in its complicated structure to admire. It consists of lobes which are made up of innumerable small lobules, and the veins wind about these lobules and between the lobes, and from these numerous capillaries are given off, until the whole looks almost like lace-work. This system of lobules, capillaries, and veins is engaged in a variety of work. In that part which we may call the laboratory, blood corpuscles are broken up and urea is formed. It is supposed that out of these decomposed red corpuscles material is obtained for the manufacture of bile, another illustration of the economy of nature.



LOBULE OF LIVER MICROSCOPICALLY EXAMINED.

The liver also has the power of taking care of the poisonous materials which are brought with the blood and are a result of the breaking up of tissue in all parts of the body. Objectionable substances which have been taken in with the food may also be taken charge of by the liver.

One great office of the liver is the manufacturing of bile, which is secreted continually and stored up in the little reservoir called the gall bladder. During digestion the greatest amount of bile is poured out, and during fasting it may entirely cease. A free use of water increases the secretion of bile. The amount is also influenced by the quantity of food we eat; the largest amount is made when we eat flesh food, a less amount with vegetable food, and a very small amount with pure fats. We learned much of the office of the bile in the chapter on the store-room.

The liver also makes what is known as glycogen, a kind of animal starch. You remember that all starchy foods must be changed into sugar before they can be absorbed, and the liver takes this sugar, makes it into glycogen, and stores it up until needed for use in the body, so we see it becomes a store-house. The amount of glycogen is increased by the use of starchy foods or of foods containing a large amount of sugar.

The movements of the diaphragm assist in forcing the bile out into the excretory duct. A relatively small amount of restraint will cause the bile to stagnate in the bile duct, and this fact is of importance when we remember that the pressure of tight clothing comes directly over the

liver. It must not be forgotten that interference with the excretion of bile will be an interference with the process of digestion and absorption, and therefore have a serious effect upon the general health.

CHAPTER XIX.

THE HOUSEKEEPER'S CLOSETS.

YOU may be a frequent and familiar guest in a household, and feel free to wander through its various apartments at will. You visit not only the library and the living room as you wish, but you go to the dining-room and kitchen. Perhaps the housekeeper shows you with pride her linen closet and her china closet, or the one where her canned fruit is stored, but in all probability she does not open to your explorations the closet where she keeps the rag-bag or the half-worn clothes she intends to remodel. There are some processes in her housekeeping that she prefers to keep to herself.

Even so in our bodily house there are rooms where work is carried on which our physiologists have not yet come to understand. It is a little strange, when the body has been studied for so many hundred years, that there should remain any part of it not fully understood. Do you open your eyes a little when I say so many hundred years, thinking I must be mistaken? If I

am, then some wiser people than I are also mistaken, for Landois and Stirling in their physiology tell us that Aristotle said three hundred and eighty-four years before Christ, that the heart propels the blood to all parts of the body, but it would seem that he did not know that it came back to the heart, although he named the *aorta* and the *venae cavae*.

About 300 B. C., two renowned doctors gave the arteries their names, thinking that they carried air because they were always empty after death; but in 131 A. D., Galen contradicted this idea because he found that blood always flowed from a wounded artery. Michael Servetus, whom Calvin had burned in 1553 A. D., discovered the circulation of the blood in the lungs, and in 1604 William Harvey demonstrated the complete circulation of the blood. In Cicero a distinction is made between venous and arterial blood. In 1608 Borelli first estimated the amount of work done by the heart, and in 1661 by means of the microscope Malpighi discovered the capillaries.

This indicates but a small part of the investigation of the body during the period previous to the last date. Since then students of physiology have been innumerable; the aids of science have vastly increased, and the functions of most organs

of the body have been watched and accurately described. But there still remain a few rooms in the bodily house which are as mysterious as those to which Blue Beard gave Fatima the key. We are not afraid, however, that they contain ghastly visions of murdered victims. These puzzling rooms are not locked against our entrance; the doors are open; we may walk in and pry around as much as we please, but with all our prying we are as yet only able to guess what is done therein. But I am inclined to think that they may appropriately be called the housekeeper's closets.

Two of these rooms are located at the back of the reception room, one on each side. They are called the tonsils, and ought not to be visible, but they are often so enlarged that they quite fill up the throat and may interfere with the breathing. Stöhr says that great quantities of white corpuscles wander out of the tonsils, but he says nothing of their wandering into them, so we can infer that the tonsils may manufacture white blood cells.

At the base of the brain are little cells called the pituitary body and the pineal gland, and that is all we can tell about them; they exist and have names. Most of the glands of the body have ducts or passages leading out of them, but these

rooms, which I call the housekeeper's closets, are known as ductless glands because there is no duct or canal to carry away whatever may be manufactured in them. One of these, the thyroid gland consists of two lobes, one on each side of the larynx connected by a cross-piece. We do not know what this gland does, but when it is taken out of an animal we know that it has tremors, that there is alteration of the motor powers, difficulty in breathing, degeneration of the connective tissue and mucous membrane, wasting away of all the tissues, especially the muscles, a diminution of the red corpuscles, a great increase of white corpuscles, and finally, imbecility and death ; so we can see that a very important work must be done in this little glandular closet, even though we do not understand it.

The thymus gland is another ductless gland located partly in the thorax, and partly in the neck. It increases in size during the first two or three years of life, then remains stationary until the tenth or fourteenth year, when it begins to grow smaller, and finally disappears altogether. It is supposed that it has the functions of the true lymph gland.

Over the top of each kidney is fitted a little cap called the supra-renal capsule. It belongs with the mysterious rooms, and is supposed to

have something to do with regulating the amount of pigment or coloring matter produced in the blood. This is a guess based upon the fact that, when they are diseased, the skin becomes of a brown color.

The largest and most important of these puzzling rooms is called the spleen. It is located in the left side of the abdominal cavity above the hip. Its structure is much like that of the sponge. It is largely supplied with blood vessels, and what it does is guessed at from the effects of its removal, from the changes which the blood undergoes in passing through it, from its chemical composition, from the results of experiments upon it and from the effects of disease.

When the spleen has been removed, the lymphatic glands enlarge and the blood-forming power of the red marrow of bones is increased. I think I did not tell you about that property of the red marrow of bones. There are two kinds of marrow in bones, the red and yellow; the yellow consists chiefly of fat, and is found principally in the long bones of the limbs, while the cavities inside the bones of the head and trunk are filled with red marrow which has the power of making new red blood corpuscles, so that I think these cavities in the bones may properly be classed with the housekeeper's closets.

But to continue concerning the effects of removing the spleen. The number of red blood corpuscles is diminished, the white ones are increased in number, while the lymphatic glands, especially those of the neck, increase in size. This experiment would seem to indicate that the spleen makes white blood corpuscles and destroys red ones. After a meal, the spleen increases in size, and is usually largest about five hours after digestion has begun, and this probably has some relation to the manufacture of white corpuscles. There is a relation between the spleen and the liver, for it is found that when the spleen contracts, the liver enlarges. It is observed also that depressing emotions, such as grief or sorrow, increase the size of the spleen, while the exhilarating emotions diminish it, so there may possibly be a real connection between the irritable mental condition of a person, which we sometimes speak of as splenetic, and the state of the spleen.

CHAPTER XX.

THE ELECTRICAL APPARATUS.

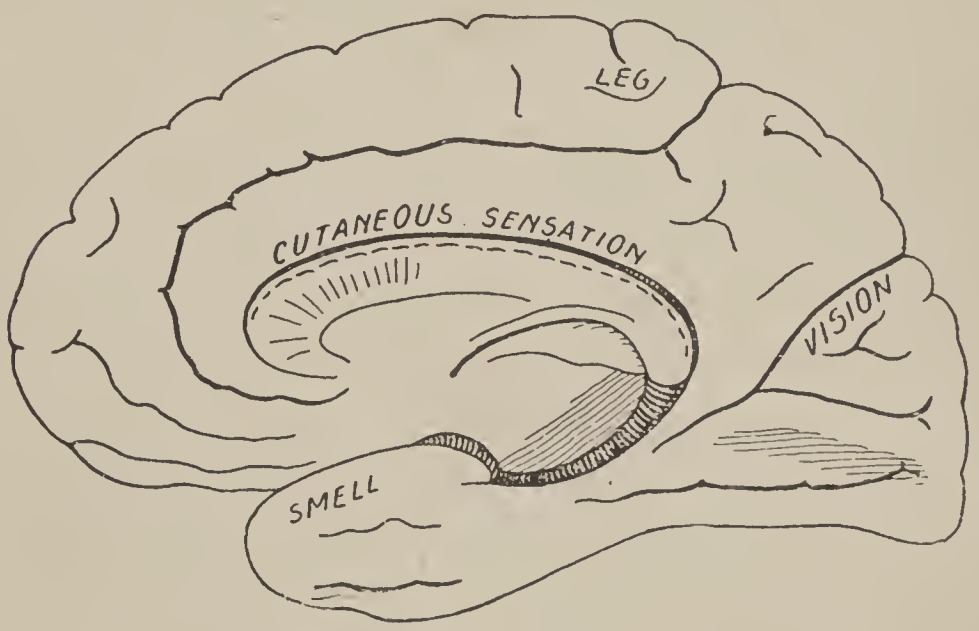
THE brain, as we have learned, is a busy workshop, and here is located the telegraph office through which Man sends messages to all parts of the house. The brain cells are the electric batteries, and the nerves are the telegraph wires. You will remember that the spinal column is made of twenty-six bones with a hole in the center of each, and these placed one over the other make a long tube, and in this tube runs a cord made of white and gray matter like the brain, only the position is reversed, the gray being on the inside and the white outside. A college student once defined the spinal cord as the "cord the vertebræ are strung on," which was not such a very bad definition after all. It is calculated that there are as many as nine hundred million of the little cells in the brain, which generate the nervous current that corresponds to the electricity of the telegraph ; and in the spine are other cells which we may call branch batteries.

From the brain twelve pairs of nerve-cables start out to carry messages to the eye, the ear, the nose and other parts in the region of the head. From the spinal cord thirty-one pairs go to all parts of the body. These nerves form what is called the cerebro-spinal nervous system, because it originates both in the brain and spinal cord.

In the chapter on the general office, we studied the structure of nerves; now we will learn what they do. Nerve fibers of the cerebro-spinal system are of two kinds,—those of motion and those of sensation. The same nerve force is sent over each, and yet one never does the work of the other. A knot of nerve cells collected together is called a *ganglion;* the brain is a collection of these *ganglia*, and in them is generated the nerve force. There are also gangalia in the spine which transmit, and in some way modify the messages sent from the brain.

When we study the brain, we find that its various parts have each a special work to do. Certain parts have nothing to do with motion, but are centers for sensation or for special senses, as sight and hearing. Other parts of the brain have to do with motion only, and these are found in what is called the motor area of the brain. The motor area has lately been

carefully studied, and we have learned to know through just what part of the brain messages are sent to move the various parts of the body. Thus we have learned that one part of the brain governs the movements of the arms, another of



Motor Areas of the Brain.

the legs, another the muscular movements of the face; and we know, too, that the fibers of the nerves cross from one side of the brain to the opposite side of the spinal cord, so that the right brain governs the movements of the left side of the body and vice versa; an injury to one side of the brain will affect the opposite side of the body. This is very important in surgery, and to show you what skill physicians have gained in

locating the cause of a difficulty, I will quote from a case reported in the records of the Philadelphia Orthopedic Hospital : —

A young girl had fits of epilepsy ; she said in the beginning of each attack that she suffered in the right thumb. As the difficulty was of nervous origin, the doctors thought they would see if taking out that part of the brain which governed the motions of the thumb would cure the disease. As she was a mill girl, and it was very important that the use of her hand should be preserved as far as possible, they were anxious to remove only so much of the brain as governed the movements of the thumb.

They opened the skull just over the part where they knew the nerve-center that governs the thumb is located, and cut out a piece of the brain about half an inch in diameter. By the use of an electric battery they decided that they had removed all of the brain that influenced the thumb, and judged that they had taken out all that was diseased. She recovered promptly, and with perfect control of all the muscles of the shoulder, elbow, wrist, and hand, but not of those of the thumb. Every one of those were paralyzed.

Now remember, that only one half inch of the brain was removed, yet the muscles of the thumb

cover a good deal of space. One lies in the ball of the thumb; one between thumb and fore finger; one in front of the fore arm reaching almost to the elbow, and three on the back of the fore arm extending half way from wrist to elbow; but the most wonderful thing in regard to this operation I have yet to tell you. It was performed in October, 1891; by June, 1892, she had regained the entire use of her thumb. I wonder if new brain was formed, or if the motor nerve-center of the thumb on the other side, finding that his partner was gone, gradually took up his work also.

Surgeons have also learned to locate the center of speech, written or spoken. Dr. Mac Ewen relates the case of a Scotch Presbyterian, who, after an injury to his head, suffered from "mind-blindness." That is to say, his eyes were not injured, but he could not understand what he saw. He could see his well-worn New Testament before him, but comprehended nothing of what it meant, nor could he read the well-known words. The doctor removed a small piece of bone from the skull, and found a small tumor pressing on that part of the brain which governs the center of written speech. Upon removing the tumor the man was entirely cured.

We are told by these scientific investigators that the area of spoken words is on the left

side of the head unless the individual is left-handed, when this area is on the right side. All right-handed people, therefore, talk with the left side of the brain.

The cerebrum is the center of motion, speech, thought, and feeling. The small brain, or cerebellum, regulates movements.

When an order is sent from the brain to the arms or limbs to move, it must go through a motor cell of the spinal cord, and from there be re-transmitted. It seems as if the orders from the general office must be repeated at these little way stations to insure their being delivered at the right point ; and messages of sensation which are sent from the surface of the body to the brain must also pass through the repeating stations in the spinal cord.

We know that we can feel even when we do not see, so we can easily remember that the nerves of sensation pass out from the back of the spinal cord ; but if we want to act, we need to see, so we remember that the nerves of motion come from the front of the cord.

When we see how quickly a motion is made, after we have willed to make it, we can but wonder how fast the nervous current travels. If your hand were on a hot stove, a message would be sent to the brain that the hand was being burned,

then a message would be sent back to the hand to take itself away from the stove, but it would all be done so quickly you could scarcely believe that two messages had passed over the nerves before you moved.

I find the calculation in regard to the rapidity of travel of nerve force is, that it moves about one hundred and ten feet per second, so that a message from the toes to the brain would require one twentieth of a second, and the return message the same length of time ; so if the foot were hurt, it could not report the injury to the general office and receive a message in response until at least one tenth of a second had passed.

Perhaps you have sometimes thought you would like to be a telegraph operator, and here you have been one all your life but did n't know it. More than that, you not only operate but you own the whole line. Some of the messages you send or receive, you forget at once, and some you file and put away in another part of the brain, which we will learn about as the library.

I watched the head clerk in the office of an hotel the other day ; he received the travelers who came, had them register their names, assigned them rooms, and sent their baggage up after them. He ordered the call boys to answer

the bells, he heard complaints, made out the bills, took in the money, and received telegrams. He quieted an angry man, and stirred up a lazy boy. He was thinking of everything; controlling and managing everything; and I said, "How much this is like Man in his great central brain-office. He sends and receives messages; he registers guests; he thinks, plans, orders, executes; and, what is strangest of all, he perhaps does not know that he is doing anything at all remarkable."

CHAPTER XXI.

THE WONDERFUL CLOCK.

IN the great World's Fair at Vienna, Austria, in 1873, I saw a clock that would run ten years without winding. It marked the seconds, minutes, and hours; the day, week, and month; the year, and changes of the moon, and I cannot tell you how many other things besides. I thought that this was the most wonderful clock I had ever heard of, but yesterday I heard of a clock that runs by electricity and regulates and winds itself; and now that I come to think of it, I see that this is only patterning after the marvelous clock of our wonderful house. This is wound up at the beginning of life, and runs on till life's close, kept in motion and regulated by the electric nerve force.

Its measure of time is not the same as we have in our watches, and each individual house has its own time. The generality of mankind keep nearly the same bodily time, and that has created what we may call a standard time, but each individual may vary from the standard and yet be

all right. This wonderful clock we call the sympathetic nervous system. We have seen that the cerebro-spinal nervous system governs voluntary muscles. The sympathetic nerves govern involuntary muscles, and these are located inside the body. This nervous system is made up of ganglia, about fifty in number, located in the cavity of the body each side of the spinal column. They are united by nerve fibers passing from one to the other, and some fibers also pass to the spinal nerves, so that the two systems are in a way connected. The fibers from these ganglia form net-works in various parts of the cavities of the body, and each net-work is called a *plexus*, and the great plexus, which lies in the abdominal cavity, is sometimes spoken of as the abdominal brain. The cranial brain is the seat of consciousness and of thought. The abdominal brain presides over the functions of the organs of the body. It takes charge of secretion ; it controls and manages nourishment; it receives sensations and transmits motions without consulting the head clerk in the central office ; it controls the size and tone of the blood vessels ; it sends orders to the liver, causing it to manufacture bile and glycogen, and excrete urea. It may send such violent orders to the intestines that, in their haste to obey, they contract with so much force

as to cause pain or a very rapid action of the bowels. If this abdominal brain gets excited, it may order the sweat glands to pour out such a quantity of water that the person is bathed in perspiration. This brain we call the solar plexus.

The different ganglia of the sympathetic nervous system may each be called a little brain. These ganglia are found everywhere in the viscera, and are known as automatic motor centers. Those located in the heart cause it to beat,

> "Keeping, time, time, time,
> In a sort of Runic rhyme,"

not in unison with the passing seconds but a little faster, about seventy-two times in a minute.

In the intestines, the automatic motor ganglia keep up a rhythmic motion which we call *peristalsis*, moving the contents along through the alimentary canal. The reservoir of the bladder has also its contraction and dilatation ; the lungs have their rhythm, filling and emptying eighteen or twenty times a minute. Dr. Byron Robinson says the liver has also a rhythm, enlarging with influx of blood during digestion, and returning to normal size during rest. He finds that the spleen works according to rhythmic time in the same way as the liver, and so do the pancreas and kidneys. When this rhythm of the vital organs

is disturbed, we have disease. Is not this a wonderful clock that marks off the functions of the body in regular beats, some fast, some slow, some oftener than once a second, some not oftener than once a month? And as this is not under the control of our will, we must think that the divine Architect himself made it, wound it up, set it in motion, and governs it by his own power.

O wonderful clock of our earthly life,
  That beats from our birth to death,
That marks the pulsing of our hearts,
  The flowing of our breath;
God holds thy key in his own right hand,
  And watches thy pendulum swing;
He turns thy hands as thy pulses beat,
  Himself holds the strong mainspring.
And our life shall beat at his royal word,
  And shall end as his will shall be;
But the life of the soul shall pulse on and on,
  Throughout eternity.

CHAPTER XXII.

REGULATOR AND MAINSPRING.

IF you open your watch so that you can look at the works, you will see a little pointer that moves along the scale of an arc, at one end of which is the letter F, which stands for fast ; at the other end the letter S, for slow. By moving this pointer toward the one or the other, the watch is made to run faster if it is losing time, or slower if it gains.

Our wonderful clock has a regulator located in the back part of the general office. It is called the cerebellum, or little brain. Like the cerebrum, or great brain, it is composed of white and gray matter, and the two divisions of the brain are connected by the *pons Varolii*. We can move the regulators of our watches back and forth and yet really have no idea how any change is effected ; and I am compelled to tell you that we are as yet somewhat ignorant of what the cerebellum does, but it is generally admitted that it controls, regulates, — co-ordinates, physiologists say, — the movements of voluntary muscles. Experiments prove that it is not an organ of

thought, feeling, or motion, like the great brain; but its importance is indicated by the fact that its convolutions are deeper, so that there is a greater proportion of gray matter, and that, we learned, is the important nerve substance.

When we cannot find out just what the healthy organ does, we study what effect is produced by disease or injury of the organ. If the cerebellum is entirely removed from a pigeon, the animal dies. If only the superficial layer is removed, the bird becomes weak and its movements are not uniform. If a still greater part is taken away, the movements become more irregular and violent, the bird cannot fly or spring or walk perfectly. Its will is not affected, but it seems not to have the power of doing what it wants to do. When the deeper layers of the cerebellum are removed, it cannot fly or turn or walk at all; if placed on its back, it cannot get upon its legs. It will try very hard to do the things it has been accustomed to do, but all to no purpose. The limbs move, but anyhow and everyhow. It can see and hear, it has intelligence, it trys to avoid obstacles; but all its efforts are ineffectual, apparently because it cannot regulate its movements and make its muscles work together.

When we remember how many muscles may be used in making single, simple movements,

we can understand there must be some power that will regulate the nerve force sent to those muscles, so that they will work in harmony without our thinking about it. For instance, it takes six particular movements and calls into play a dozen or more muscles, to take one step in walking. It would be impossible for us to manage all that machinery by the will, to send the various messages to just the right point to flex the leg, move it forward, straighten the knee, lift the heel, rest on the toe, bring the other leg forward, and repeat these at every step. We learn to do this very slowly, carefully, and imperfectly at first. See the baby learning to walk. He does not succeed in making all the muscles work harmoniously together, but after a time the muscles get trained, the cerebellum takes control of the nerve force, and walking becomes automatic,—that is, we will to walk, and then the muscles do it themselves. But, as we have seen by the experiments made on the pigeon, the muscles could not do it, no matter how much we willed it, if the cerebellum did not take charge of matters and act as a regulator.

And now we will talk of the mainspring, which is the name I give to the *medulla oblongata;* those two words mean the oblong marrow.

We know how very important the mainspring of a watch is, or at least we find out when it is broken. Then the watch stops, and will not go until a new mainspring is put in. Unfortunately for us, when our mainspring is broken, our wonderful clock stops forever; we can never get a new spring. For that reason, the center of the medulla oblongata is called the vital knot, for injury to that stops all the machinery, and Man suddenly moves out of his bodily dwelling to live in it no more. The medulla oblongata is composed of white and gray matter, and is rather pyramidal in shape, the base being upward. It really may be called an enlargement of the spinal cord. It is about an inch and a quarter long, three fourths of an inch wide, and half an inch thick; so you see that it does not require a very big space to contain the vital knot. You will be able to judge of its location by remembering that it unites the brain and spinal cord. In the medulla, a part of the nerve fibers of one side of the brain cross over to govern the other side of the body; some of them cross in the cord itself, and some in the *pons Varolii.*

The books say that the medulla is the center of reflex influences, and I think we have said nothing about these. When I told you how long it takes for a message to go from an injured foot to

the brain and the return message to be sent, you perhaps thought it certainly could not take so long, for, if your hand or foot were hurt, you jerked it away before you thought. That was true, but it was not because the message traveled faster than I said, but because there are in the spinal cord and in the medulla some nerve centers that do not wait for commands from the brain before they send messages over the motor nerves to the muscles. The messages from the injured part reach some of these nerve centers, perhaps in the spinal cord, and they send the messages to take the hand or foot away, and it is really done before the brain has received word that any harm is threatened.

The movements resulting from these reflex influences we call involuntary movements, and certain of them originate in the nerve centers of the medulla. Sudden winking to protect the eye from injury is controlled by the medulla, and is a reflex act. Sneezing is also a reflex act; we cannot produce a real sneeze at will, but if something irritates the mucous membrane of the nose, a message to that effect is sent to the brain, and on its way passes through the medulla. The reflex nerve centers there located send back word to the muscles of expiration to put the offender out, even though we should be in church

or in some very solemn place. Coughing, swallowing, and vomiting are all reflex acts governed by the nerves of the medulla.

The cerebro-spinal and the sympathetic nervous systems are closely united, so, by the action of the cerebro-spinal nerves, we can, by our wills, govern some things to a certain point. Then the sympathetic system takes control, and our will is set aside. This is the case with breathing. The lungs are mechanically self-adjusting through the nerve centers of the medulla, and breathing is really a reflex act. Taking in the breath stimulates the fibers which act reflexly on the nerve centers governing the breathing out; and lessening the size of the lungs in breathing out acts reflexly on the nerves which govern the breathing-in muscles, and so the lungs keep continually at work.

In the medulla also reside the nerves which govern the rhythmical action of the heart. Is it not marvelous that so small an organ as the medulla oblongata can have such a wonderful controlling power over the various organs of the body, keeping them moving in time and tune so that there will be no discord in the song of life?

CHAPTER XXIII.

SPECIAL WATCHMEN.

WHEN a man owns an elegant mansion, he is often not satisfied with the guard kept over it by the regular police, but employs special watchmen. Our bodily house has five such watchmen called special senses, and named Sight, Hearing, Smell, Taste, and Touch. We have already studied these under other titles ; we must now learn how they are special guards protecting us from danger.

Sight dwells in the eye, and we can readily see how he is a protection. If you have ever seen a blind man walking alone through the streets of a city, you have been impressed by the dangers with which he is surrounded ; the people, the gutters, the street crossings, the teams, the open cellar doors, and the lamp-posts, are all possible causes of injury which he can avoid only by carefully feeling his way with his cane ; but you, with your quick, keen eyes, can run through the crowded thoroughfares, avoiding the open doors, dodging the teams, jumping over the gutters, and

go four blocks while he is warily picking his way across one.

Hearing is also a great protection against dangers which come from directions where man cannot see. If danger is approaching from the rear, he may be warned by his ears. It is not quite as unsafe for the deaf man to go about alone as it is for the blind man, and yet he is in great danger. He does not hear the runaway horses that are dashing upon him, or the whistle of the train, or the bell of the electric street-car, and so may be killed even though he has the sense of sight. People sometimes ask each other whether they would rather be blind or deaf. Each condition has its inconveniences and perils, and each its compensations, The blind man cannot see his friends, cannot read the ordinary printed page, cannot enjoy the sunset or the landscape; but he can hear the voices of people and the songs of birds, can listen to the lecture or the concert, even though it be in darkness, and with his fingers, by the aid of his friend Touch, can learn to read the raised printing made especially for the blind. The deaf man can see all the beauties of nature and art, can walk unattended, can read books and papers, but cannot hear. Did you ever think what it would be to live in a world without sound; to see life in all its activities

pass like a panorama before you ; to see people laugh, and not know what they are laughing at, to see people talk and not know what they are talking about ? It must be a great trial, and I wonder at the patience of deaf people, and feel that we have not half the sympathy with them that we should have.

We learned of Taste as the guard in a pink uniform, who lives in the reception room. His position is one of great responsibility, but he is not always to be entirely relied upon. He can be taught to be very fond of hurtful things and to admit into the house guests that are determined to do great injury. The tongue, the residence of Taste, has one nerve of motion, and two of sensation. On the tongue are little points called *papillæ*, in which Taste especially dwells. Objects to be tasted must be dissolved either in water or in the fluids of the mouth.

It is rather queer that some things taste different on the tip of the tongue from what they do on the back of the tongue ; for example, alum tastes sour on the tip and sweet on the back of the tongue ; sulphate of sodium tastes salty on the tip and bitter on the back. If Taste were left to his own uneducated sense, it is quite doubtful if he would ever admit to the house any very salty, fiery, or bitter visitors ; but if often

introduced to them, he after a time begins to tolerate them, and ends by liking them, and then his judgment as a guard is impaired. It should be our aim to allow him to become acquainted only with those who visit us with motives of helpfulness, and of these we shall speak when we interview the guests of Man in his bodily house.

Smell, another special watchman, resides in the porch of the nose in the lining which, as we learned, is called the Schneiderian membrane. He can be trained to great acuteness, or he can be very dull and unreliable. In the savage, the sense of smell becomes a great source of information, as it is in many animals. Humboldt says that certain South American Indians can smell a stranger in the dark, and tell whether he is white or black. It is very important that a cook should have the keen sense of smell in order to judge of the quality and conditions of food, and also to know whether things on the stove are burning, and make a report to the central office.

The special nerve of smell is called the olfactory nerve. When irritating substances are taken into the nose, its nerves of sensation are aroused, and they send the offender out with a noise we call sneezing, so that these nerves of sensation are also special watchmen. The sense

of smell is given us for enjoyment as well as protection. It delights in the odor of flowers and perfumes, and the pleasure of eating is increased by the odor of food.

One special purpose of smell is to warn us against bad air. Does our good fairy Aura ever get naughty? Aura is quite like people; she becomes bad by keeping bad company. As long as she is associated with good company she brings only pure and enjoyable odors to the sense of smell; but when she mingles with disreputable members of the Gas family, she brings to the house some guests that make Smell feel inclined to shut the door in her face; and if he makes a loud enough complaint to the central office, Man hears and sets matters right by moving his quarters, or by sending Aura's bad companions where they cannot come into the house. If Man pays no attention to the complaint, Smell gets tired of grumbling, and Aura may take with her into the laundry a good many guests that badly need washing themselves, and we have no arrangements for washing outside tramps; the laundry is arranged only for the purpose of attending to the members of our own household, so it is quite important that we heed the first warning of Smell when he reports that Aura is coming in with undesirable visitors.

The last of our special watchmen is Touch, and he resides in what are called the tactile corpuscles of the nerves of sensation. How much our physiologists delight in big words! But I don't begin to tell you half the long words they use for I don't want to frighten you away from the study of your wonderful house.

You remember that the nerves of sensation carry messages from the outside of the body to the brain. By them we learn the form of substances, their hardness, smoothness, and temperature. If the nerves are unpleasantly impressed at any time, they report at once to Man, and so warn him of danger, and this warning we call pain; thus we see that Pain, instead of being an enemy, is one of our best friends, and whenever we feel pain, we should remember that it is a kindly warning. Some people act as if Pain were a foe who must be silenced at any cost, so they do all they possibly can to make him keep still. The wiser plan is to learn, if possible, what it is that makes him cry out, and then remove the cause. If it were not for Pain warning us of danger, we might be so seriously injured before we knew what was being done that there would be no way to cure the injury. It seems hard that the dear little baby should be hurt when he falls, or is burned by the fire, or cut by

the knife, but by these methods Pain is teaching him to be careful, and to guard himself against danger.

Muscular Sense may be classed among the special watchmen. This is a term used to denote the knowledge which the muscles have of their own state. For example, with your eyes shut you know whether the thumb is bent in or out, or in which direction the foot may be turned. That this does not come from knowing that you willed the thumb to be bent or the foot to be turned in a certain direction, may be proven by having some one else move your hand or foot, and see if you cannot tell in which direction it is moved.

Muscular Sense also gives us knowledge of weights lifted and the amount of power to be employed in overcoming resistance. If we see an object we can calculate its weight, but if it be wrapped in something and so hidden from sight, we can judge of its weight as we lift it, and can guess whether it is one pound or ten. This is done by Muscular Sense.

This sense also helps us to keep our balance in standing erect; and when it is impaired, the person finds it very difficult to stand or walk straight. The man who counts money in a bank has this sense greatly developed, for he detects

instantly the coin that is of light weight. Where this sense is defective in the arms, the person will drop what he is carrying unless he constantly thinks of it. Such a one would not make a very trustworthy nurse, and I would not want to be the baby she cared for, would you ?

In cases of defective muscular sense, the eyes, in a measure, take its place, so that the person may be able to walk fairly well with his eyes open, but will stagger like a drunken man if they are shut. Like all of the senses, this sense can be cultivated, and by its education becomes of greater value and a surer guardian.

CHAPTER XXIV.

THE WINDOWS.

WE might expect that a building so important as our marvelous mansion would have many windows. In fact it has only two, but these are worthy of our admiration. Over them are hung beautiful awnings trimmed with a fringe corresponding in color to that of the house itself. The divine Architect makes nothing for ornament only, and so this fringe acts as a guard to sweep away intruders. The awnings are lined with a delicate pink membrane, called the *conjunctiva*, which is reflected downward over the windows themselves as a netting or screen.

These awnings also serve to wash the windows. They are raised and lowered noiselessly by means of small muscles, at the will of the occupant. I said at the will of the occupant, but, in fact, they are being raised and lowered continually whether he thinks about it or not, and this is called winking. Close up under the eyelid, is a little sac or gland which secretes a fluid, and the winking spreads this fluid over the surface of the eye. On the lower eyelid near the nose is the opening

of a little canal through which the fluid passes downward into the nose, so the winking is, in reality, a washing of the windows. Would not our housekeepers think it a fine thing if some genius would invent an awning that would wash windows after this fashion? Sometimes the fluid accumulates so fast that it cannot be disposed of through the canal, but overflows upon the cheek; this we call crying or shedding tears. Along the lower lid is a row of little oil glands, and the oily secretion keeps the lids from sticking together when they are shut; and, as oil and water will not mix, it serves also to keep the tears from overflowing on the cheeks. When the awnings are raised, we can see the beautiful transparent windows through which Man looks out upon the world. And when at night he is tired of looking, and draws the awnings down over the windows, we say he is asleep.

At each window hangs a circular curtain, colored in harmony with the tinting of the house, adding greatly to its beauty. In its center is a circular opening which looks to us like a round black spot in the center of the eye. There is a small muscle around this opening which has the power of contracting and making the hole small when the light is too strong, or relaxing and making the hole large if the light is too weak.

The transparent window in front of the curtain, in shape like the crystal of a watch, is called the cornea. The curtain is called the iris, which means rainbow.

Through these rainbow-tinted windows Man becomes acquainted with all the beauties of nature and art, and through these windows we come most near to catching a glimpse of Man himself. If we can read the language of the eye we shall know the thoughts. The lips may speak falsely but the eyes do not lie, and may contradict the spoken word. The lips may be silent, and the eye speak so eloquently of gratitude, affection, or confidence that words are needless. With the eyes closed light dies out of the face, so no wonder that the faces of the blind are lacking in expression, while the face of a deaf-mute, who hears with his eyes, glows with the intensity of his own thoughts and with the reflection of the varying phases of life around him.

We often hear of "the tell-tale eye," and when we are in doubt of the truth of the statement, we say, "Can you look me in the eye and say that?" I trust that we shall each keep a soul so pure and true that we shall always be able to look the whole world in the face with an open, honest glance from our soul-windows.

CHAPTER XXV.

THE PHOTOGRAPHIC CAMERA.

So many people now-a-days are interested in the study of photography that you will be pleased to hear that the eye is a photographic camera. A photograph is made by using a plate of glass covered with a film which is sensitive to light. This sensitive plate is placed in a box, with a small opening through which the light enters. The object to be photographed is placed in front of this box, or camera, as it is called, and the light reflected from the object, passing through the opening in the box, acts upon the sensitive plate and produces the image. The light parts of the object act strongly upon the plate ; the dark parts or shadows act feebly and thus a life-like image is obtained.

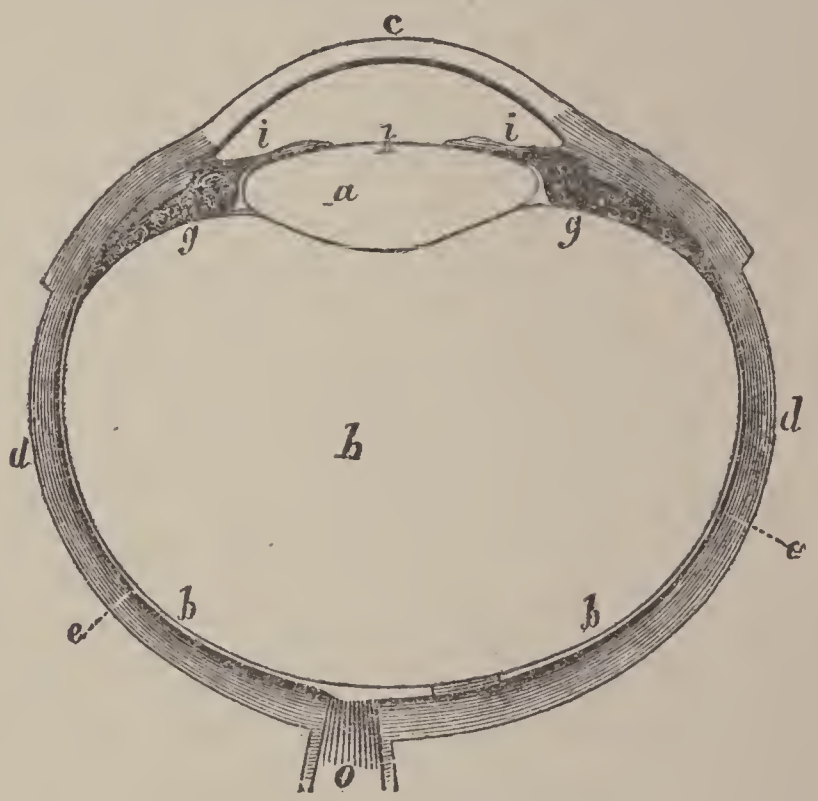
You see if it were not for light and shade there could be no picture. I have read that Queen Elizabeth was very much offended with the artist who in painting her portrait made some parts of her face darker than others, saying that her face did not have such dark spots upon it, which

shows that, highly educated as she was, she did not understand the necessity of shadows in a picture.

It is very interesting to notice how closely the eye in its structure resembles the photographer's camera. In shape, the eyeball is nearly spherical. The interior is a soft, jelly-like, transparent substance called the vitreous humor from the Latin word *vitreous*, glassy. This vitreous humor is, in shape, much like a rubber ball dented in on one side. The dented place is just back of the iris, and in the space between the two is fitted the crystalline lens.

The vitreous humor is surrounded by a very delicate, transparent membrane which splits into two layers when it reaches the lens, enclosing its edges and holding it in place. Just outside of this comes a coat called the retina, from a Latin word meaning network, which covers two thirds of the eyeball and ends in scalloped edges, the *orra serrata*. This retina is the most important part of the eye, for it is really the organ of sight. Although it is extremely delicate, it is a very complicated structure, having no less than eight distinct layers of tubes, fibers, cells, and granular matter, all of which, no doubt, are very important, but which we do not fully understand. Outside of the retina is a covering called the

choroid coat, from a Greek word meaning leather, because it is dark brown or almost black in color. This covers all of the eyeball except the part in front which is occupied with the transparent window, the cornea, of which I have told you.



THE EYE.

d. The sclerotic.
e. The choroid.
o. The optic nerve.
k. The pupil.
h. The vitreous humor.
c. The cornea.
b. The retina.
a. The crystalline lens.
g. The ciliary processes.
i. The iris.

Outside of all is a strong membrane which is called the *sclerotic*, from a Greek word meaning hard, because it is the toughest coat of the eye. The sclerotic unites with the choroid coat around the edge of the cornea.

Do you think now you have a good idea of the eye? Take your rubber ball and dent it in on one side. In front of this dent place your watch crystal. Imagine that your ball has two outer coverings that unite around the edge of the crystal, holding it in place. Inside of these two coverings is a delicate network of the retina, and the ball itself represents the vitreous humor. The watch crystal represents the cornea. Back of this cornea stretch a colored curtain with a hole in the center, and just back of this hole, in the dented place of the ball, put a double convex lens, and you will have a very good representation of the eye. The eyeball thus completed is surrounded by a cushion of fat which fills the bony cavity of the socket of the eye so that it can turn easily without injury. To the eyeball are attached six muscles which enable it to be moved in all directions. One of them is of particular interest because it runs over a pulley.

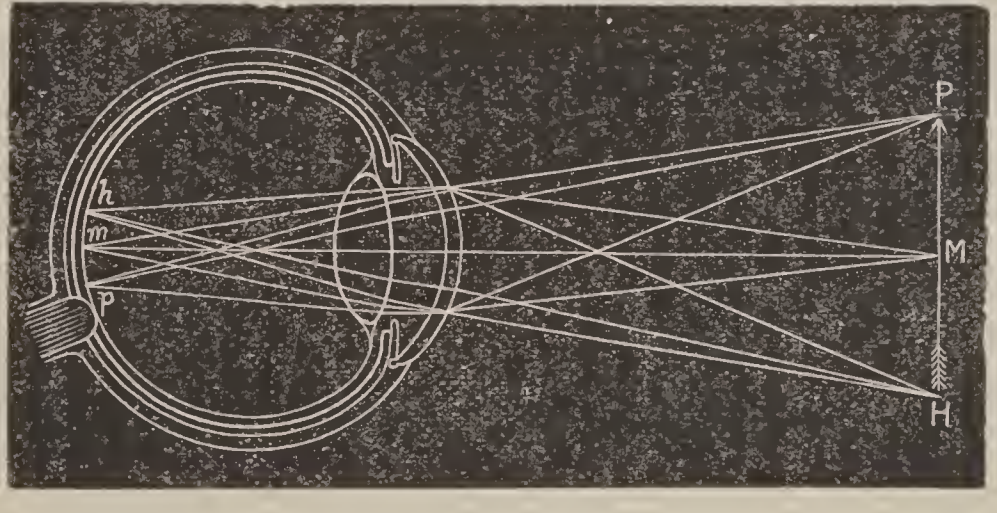
And now we will see how the eye and the camera compare with each other. The camera is a box with only one opening to admit light. We may say the same of the eye. The camera is painted a dull black inside; the eye has its dark choroid coat. In the opening in front of the camera is a brass tube fitted with a double

convex lens, and this tube is lengthened or shortened by means of a screw. The eye has its convex lens which changes its shape instead of being moved forward and backward. No light can enter the camera except through the one opening, and it must pass through the lens to reach the sensitive plate; no light can enter the eye except through the circular opening of the iris, and it must pass through the lens before it reaches the sensitive plate of the retina.

In the camera, the lens is altered in its position so as to bring the rays of light to a point or focus, as it is called, just at the right place. In the eye this is accomplished by changing the shape of the lens. A lens is a glass shaped so as to bend or refract the rays of light so that, entering the lens parallel, they will be changed in direction. A convex lens bends the rays so that they will all come together at one point, and the more convex the lens, the sooner will the rays of light come together. In the eye this bending of the rays is aided by the cornea and also by the aqueous and vitreous humors, as well as by the changing of the shape of the lens. The ciliary muscles which surround the lens contract and make it more convex, or relax and flatten it. The nearer the object, the more convex the lens becomes; the farther away the object, the more the

lens flattens. This is called the power of accommodation of the eye, and its purpose is to focus the rays of light directly on the retina.

When we look at a photograph, if we see that the features are not clear and distinct, we say that the person was out of focus; by that we mean that he was not placed so that the rays of light reflected from him would come to a point



Showing how the Rays from an Object Focus on the Retina.

just exactly on the sensitive plate, therefore the image is more or less blurred.

In looking at an object, if you move it backward and forward, you will find a point where everything looks clear; but if you move it much closer or farther away, everything becomes indistinct. In normal vision the image of a distinct object is formed directly on the retina without any effort of the eye. This distance,

about seventy yards or upwards, is called the remote point of vision. When the object comes nearer than this, the lens must begin to get more convex so as to bring the rays of light to a point sooner, and this convexity is increased until at last the object is so near that even with a straining effort it can no longer be distinctly seen. The closest point at which an object can be distinctly seen is, in the normal eye, about six inches. This is called the near point of vision. The eye can change or accommodate from a near to a distant object more rapidly than from a distant to a near object, because this change is a flattening of the lens by a relaxation of the ciliary muscles, and they can relax more quickly than they can contract to make the lens more convex.

If the eye is not normal, it may perhaps be too short from front to back, in which case the person is far-sighted. That is, the rays of light do not come together soon enough and so focus beyond the retina and the object will have to be moved farther away to be seen distinctly, or the defect can be remedied by wearing spectacles with a convex lens, which will help to focus the rays sooner. If the eye-ball is too long from front to back, the rays come to a focus too soon and the image will be formed in front of the retina. In this case, the person moves the object

closer so as to focus the rays on the retina. He is short-sighted, or near-sighted, and his glasses need to be concave so as to slightly disperse the rays and keep them from coming to a focus too soon.

But all the light in the world would not produce sight if there were not some arrangement for sending messages to the brain. Light strikes on the nerves of the retina, they communicate sensation to the optic nerve, and it carries them on to the brain, and man becomes aware of what is passing before his eyes. This optic nerve has not the power of receiving impressions of light, it can only tell what the retina reports. Where the optic nerve enters the eye, there is no sight, and this is called the blind spot. This nerve enters the eye a little to one side, so this blind spot does not interfere with our vision. If you are doubtful about having a blind spot in your eye you can prove it for yourself. Hold your two thumbs side by side before your eyes, about the distance you would hold a book in reading. Shut your left eye and fix your right eye on the nail of your left thumb. You are not making an effort now to see the right thumb but you still can see it. Now move the right thumb slowly away to one side and you will find there will be a spot where you cannot see the right thumb at

all, although you can see the shut hand ; but a little further on you will see the thumb again though all this time you have been looking steadily at the left thumb.

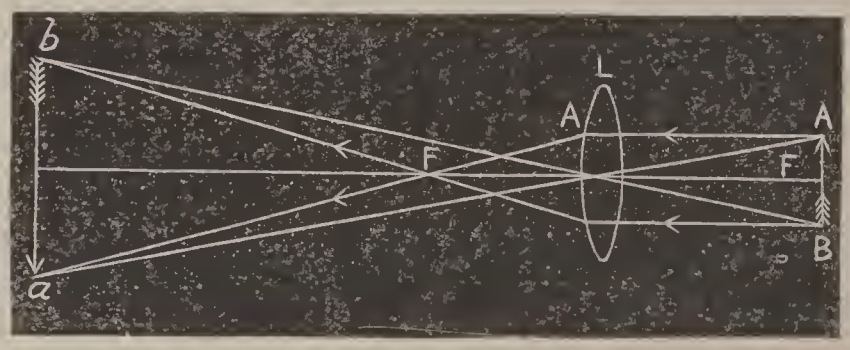
The most sensitive part of the retina is directly in the center of the back of the eye. Here is a yellow spot where there are no fibers of the optic nerve, and the cones of the retina are very numerous. In looking at large objects we move the eyes so the different parts of the object are one after another brought into line with this yellow spot, then the brain takes all the separate impressions and puts them together in one image and judges of them as a whole, but we do this so quickly and so constantly that we do not realize that we are doing it. This rapid motion of the eyes in seeing, and our ability to notice only the vivid impressions, are the reasons why we are unconscious of our blind spot. I think it would be a good thing if we could turn our blind spot toward the unpleasant things of life and not see them at all.

The stimulation of light upon the retina may last one eighth of a second after the object which reflected the light is removed, and it remains visible for that length of time to the eye, although in reality not present, so two impressions may follow each other so quickly as to seem to be

continuous. A wheel may revolve so rapidly that the spokes seem to blend and become a solid, or a string with something bright at the end may be whirled so fast that we seem to see a bright circle. I saw not long ago a little Peep Show called a Zoetrope, which was made very interesting by understanding this fact. Looking through the peep-holes I saw a man apparently running and jumping into a barrel and out again, in and out, in and out, as if he really were alive. A horse jumped over a hurdle, a man ran up a ladder and into the open mouth of a giant that closed upon him. When the revolving wheel stood still I saw that on a band of paper were pictures representing these men and animals in the various positions of running and jumping, and when the wheel was set in rapid motion the effect of real life was produced.

We have learned that there are many things going on in the eye of which we are unconscious. We do not realize that in vision we receive a multitude of impressions which the brain puts together in a complete whole. We are not conscious of changing the shape of the lens to bring the rays to a focus on the retina. We do not think anything about having a blind spot, and we are not practically aware of the fact that

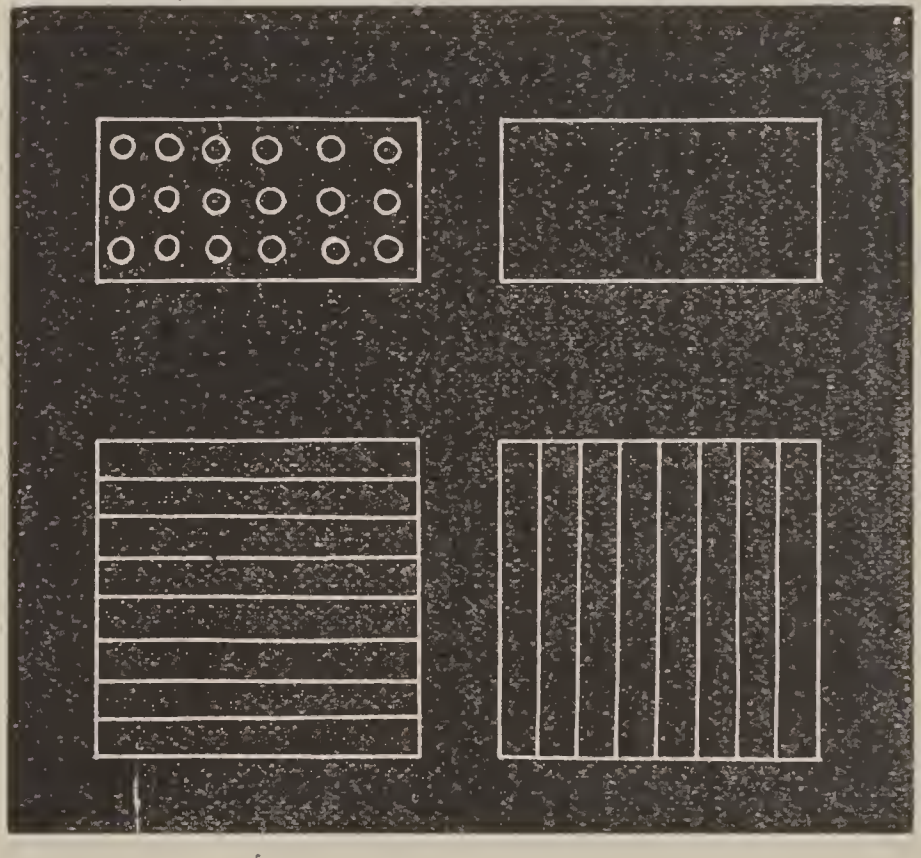
we see everything upside down. The accompanying figure will perhaps explain why : —



You see the rays at A are bent by the lens and focus at *a*, and those from B at *b* and rays from every other point along the line from A to B are focused at corresponding points between *a* and *b*, so that we have a distinct image at the line *a* and *b* of the object A and B, but much smaller and inverted. You can hardly believe that you see everything upside down in this way, but that is what the scientists tell us, and they have proved it by their experiments ; so I suppose we will have to believe them, while at the same time we are quite sure that we see things right side up.

It is quite impossible for us to realize how much of our perception of objects by sight is the result of education. I have just read of an individual born with a film over the eyes which was

removed after he had grown to maturity. When he first looked at things, he thought they touched his eyes, and when he put his hand to his eye, was surprised at not finding the object there and that he had to walk, often some distance, before



he could touch it. He was obliged to train his eyes by means of his other senses.

We learn to judge of the size of objects by sight, but this is not altogether reliable ; as for example, a space that is filled with objects seems to be larger than the same space if blank. A space with horizontal lines will seem shorter than

the same space marked with vertical lines. This fact is a good guide in the matter of dress. A person looks shorter in horizontally striped goods and taller when it is striped vertically.

We are able to judge of the solidity of objects because we look at them with two eyes. The image formed in each eye is not exactly the same ; we can see just a little further around on one side of the object with one eye than with the other, and when the brain puts these two images together, we get the idea of perspective. If you will look at an object first with one eye shut, and then with the other, you will see just how different the view taken by each eye. You have seen a stereoscope ? Well, it is made on the same principle as the eye. There are two pictures taken from a slightly different point of view and looked at through two lenses separated by a partition so that the pictures blend into one. So the eyes are lenses separated by the partition of the nose, and the two views which they see of an object are blended and give us the idea of form and solidity.

Why do not all objects seem of the same color ? Ah, now you have asked an interesting question, and, although I may not be able to answer it fully, I hope you will continue to study the subject until you have learned all about it.

Sunlight seems white, but is made by the union of seven colors. The three primary colors are red, blue, and yellow, and these uniting make the seven, as we see them in the rainbow. Green is made of blue and yellow, orange of red and yellow ; red and blue make violet, and violet and blue make indigo. Isaac Newton arranged these colors in the order of the rainbow on a disk, and rotating it with great rapidity saw that they blended and the disk looked of a dull white. If an object lets all the rays of light pass through it, it will have no color, and is called translucent. If it allows none of the rays to pass through it, but reflects or sends them all back to the eye, the object looks white. If it absorbs all and reflects none, it appears black. If it reflects only red rays, absorbing all the others, it looks red, and so with all the other primary colors. If it reflects some blue and some yellow rays, it looks green, and so on.

How does the retina then tell us the story as to the reflection of light by the object, for the retina must be sensitive to all rays ? It is supposed that certain nerve fibers are excited by certain colors ; or to speak accurately, there are three sets of fibers affected by the three primary colors, and the way in which these fibers are affected will produce the various tints. If all

are aroused, they produce a sensation of white; red will affect those fibers sensitive to red rays; green will arouse those sensitive to blue and yellow, and in this way the various combinations of color are made known to us. This theory would account for color-blindness on the supposition that the fibers which should be sensitive to some certain color do not respond to that color.

Color adds much to the beauty of the world. Just think how gloomy it would be if everything were of a dull gray or brown! Even the most beautiful color impartially given to every object would become monotonous. Those who are color-blind lose much of the pleasure of sight, but the matter becomes of more serious import when we realize how the safety and life of people depend upon the power of the engineer or pilot to recognize the color of danger signals.

Color-blindness is much more common among men than women. One eminent oculist asserts that among twelve thousand children, he found ten girls and four hundred and eighty boys who were color-blind, and among a large audience of men and women, ten per cent of the men were color-blind, but not one woman. Some physicians are inclined to attribute this prevalence of color-blindness among boys and men to the use of tobacco.

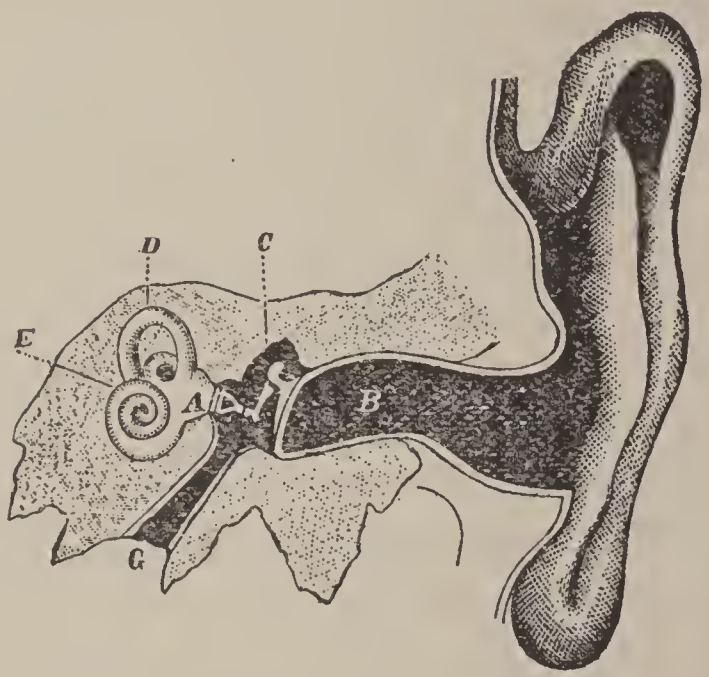
CHAPTER XXVI.

THE MUSIC ROOM.

ON either side of the cupola are two very pretty porticoes which protect the entrance to a wonderful music room where music is never made, but where it is heard. Our good fairy Aura is a fine musician, but while she sings in one room her music is not heard there but in another, and Aura runs from one room to the other carrying the tones through these porticoes of the external ear to the place where they can be heard.

The porticoes are convoluted and fluted in various ways that add to their beauty. But these curvings are not wholly for looks, for we are told that they all help Aura to find her way into the circular passages that lead inward. These passages are protected by hairy guards who, however, never interfere with Aura. She goes with step brisk or slow through the porticoes, along the passages, until she comes to a curtain stretched tightly across the way. There is no opening in it, and it will not move, so what can she do? Ah, Aura is a fairy, and she can be in

more than one place at a time. She is also on the other side of this curtain, which is called the tympanum. How did she get through, if there is no door in this immovable curtain? Perhaps you will remember that there are seven passages leading from the throat, and two of these lead



THE EXTERNAL, MIDDLE, AND INTERNAL EAR, SHOWING THE SMALL BONES, AND THE COCHLEA.

into the ears; they are called the Eustachian tubes. Through these Aura finds her way into the cavity that is known as the drum of the ear. If you shut your mouth tightly, and hold your nose, and then try to breathe out, you can feel her rush through these tubes into the middle ear.

You all know how a drum is made, but do you know that a drum must have air on the inside or it will not sound? The membrane of the tympanum is the head of the drum. But a drum will make no music unless some one pounds on it. Well, Aura knows that, and so she pounds with little blows that are called waves of air, and the tympanum vibrates, and this is the beginning of hearing, but it is only the beginning.

The cavity into which the Eustachian tubes lead is called the middle ear, and here Aura has some funny playthings. One is a little hammer; another, an anvil; the third, a stirrup. They are all made of bone, and with them Aura makes Man hear the sound she brings. The little hammer is suspended by tiny muscles so that one end touches the tympanum, the other end touches the anvil, and the anvil is connected to the stirrup, and the stirrup is fitted into an oval window which is also closed by a tight membranous curtain. The room on the other side of this window is very small and is called the vestibule. Out of this open three passages called semi-circular canals; they are tubes and are like loops; one goes backward, one forward, and one is horizontal. If you go out of the vestibule through one of these canals, you come into the vestibule again, and that would make six openings if it

were not that two of them unite at one point and enter the vestibule by a common way, From the fore-part of the vestibule passes another tube which coils two and a half times around like a snail shell, and so is called the *cochlea*. All of these tubes, forming what is called the labyrinth, are of bone, are lined by membranes, and filled with a fluid. In the vestibule are a number of six-sided crystals of carbonate of lime called *otoliths*, or bonestones, which vibrate in the fluid and strike against the hair-like projections growing from the walls and seemingly connected with the nerve fibers. If we cut into the cochlea, we will see a central, bony pillar around which the tube winds two and a half times, and is divided into three compartments, one called the staircase of the vestibule; one, the staircase of the tympanum; and one, the middle staircase.

At the top of the staircase of the vestibule we pass through a small opening, and go down the staircase of the tympanum to a round window. Do you understand that the floor of one staircase is the roof of the staircase below it, so the middle one is roofed by the floor of the one above, and floored by the roof of the one below? This middle staircase is filled with a fluid, and in here is the organ of Corti, a very complicated structure

made of two parts resting on each other and forming an arch. It is estimated that there are not less than 3000 of these arches from which stiff hairs project.

After passing the little oval window, we are in what is called the internal ear. When Aura enters the passage of the external ear, she goes on until she reaches the tympanum. Then she strikes it with many blows that make it shake. This motion is conducted through the hammer to the anvil, and on to the stirrup, which, pressing against the curtain in the oval window, makes that vibrate, and that shakes the fluid in the vestibule, and this motion vibrates the membranes and fluids of the cochlea, and the vibration of the fluids in the middle staircase sets all these little hairs of the organ of Corti in motion, and they touch the nerve fibers and cause messages to be sent to Man in the general office of the brain.

But if all this is needed to perceive sound at all, we do not yet understand how we can distinguish such a multitude of sounds one from the other. The song of the canary does not sound like that of the nightingale, the buzz of the fly is not like that of the mosquito. We learn to know the voices of different people, we distinguish high tones from low tones, loud sounds from soft ones. We know the sound of the wind, the sea, the

tones of the piano or violin, the cry of pain or the laugh of joy. Can we explain all this? Perhaps not fully, yet we can tell something about it. If we take two tuning forks, both sounding the same note, and set them up some distance from each other and strike one, we shall soon hear that the other is singing too; this is called sympathetic vibration. Perhaps you thought it was only live folks that sympathize. You know when you see any one laugh, you want to laugh ; if they cry, you feel like crying, but here are two pieces of metal, and when one sings, the other begins to sing,—that is, if they are both tuned to the same note ; if they are not, then one may sing all it pleases and the other will be silent.

The explanation is this : Each sound makes its own vibration of the air. It is like dropping a stone into the water and starting the little circles of waves into motion. Any impulse given to the air makes little waves which travel on and on. The waves made by striking the one tuning fork went on till they struck the other one, and as that was also its key, it responded. If we should put up a great number of these tuning forks, all tuned to different keys, and a tune was played in a room on any musical instrument, each fork would answer when its key-note was struck just

as if its name had been called, and one could tell just what notes had been sounded by seeing which forks were vibrating. If our supply of tuning forks were so great that we had one for every sound that could be made, each sound would set some one of them in motion. That is just what we suppose we have in the ear in this wonderful organ of Corti. Do you wonder that I call the ear a music-room? If each hair of the organ of Corti is sensitive to a particular vibration, and communicates that vibration to a nerve-fiber, then we hear the sound that corresponds to it.

If vibrations are slow, they produce low tones; if fast, they produce high tones. According to Peyer, 23 vibrations per second are the lowest we can hear, and 40,960 vibrations per second, the highest. This makes a range of about eleven and a half octaves.

The ear may be educated to analyze sounds. The skilled physician listening to the beating of the heart can detect sounds that would wholly escape the untrained ear, and the musician can hear the notes that make harmony of music where the uneducated ear hears but the prominent tones that form the melody.

CHAPTER XXVII.

THE ORCHESTRION.

THE Standard dictionary defines an orchestrion as a musical instrument designed to imitate an orchestra, and I think we have such an instrument in our wonderful house. Unlike the complicated organ of hearing it is very simple in construction, although capable of making a marvelous variety of sounds. It can talk and sing, it can laugh and cry, it can mew like a cat and bark like a dog, crow like a rooster, neigh like a horse, and trill like a bird. Did you ever see one of these strolling musicians who tries to be a whole band in himself? He has a bag-pipe under his arm, cymbals attached to his knees, a drum strapped on his back, and I do n't know what other instruments fastened to him elsewhere, and he manages to strike each of them once in a while. Of course, he has to stay in one place while playing, and there is very little music to it, after all. It is only a very poor imitation of what we are constantly doing with

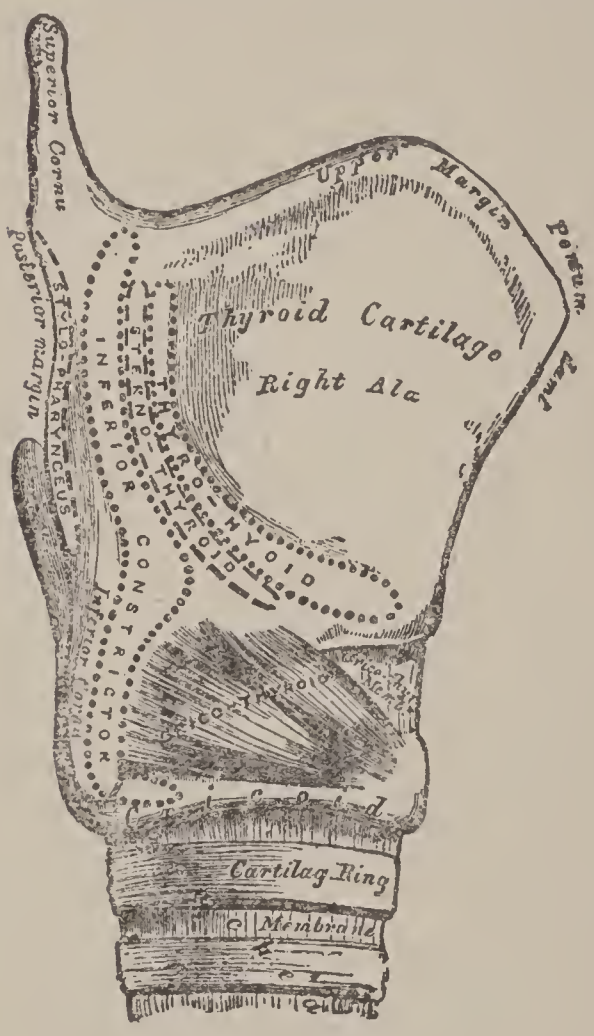
our orchestrion without thinking that we are doing anything wonderful.

In the first place, we do not have a lot of instruments hung clumsily about us in various places, but our orchestrion is a compact little box that we carry in our throats. We are not obliged to stand still when we use it ; we can walk, run, or work while talking or singing.

Our musical instrument is located at the top of the laundry stairs, and is called the larynx or voice-box. Aura comes through the voice-box every time we breathe, but she comes softly unless Man wants to use his musical instrument in some way, and then she is ready to play it for him, and without her he could make no audible music.

The larynx is a cartilaginous box, without top or bottom, set at the top of the trachea. The little trap-door of the epiglottis shuts down over it when food is passing, but lifts to admit air. If you look at the picture of the larynx, you will see that the greater part of it is made of two large cartilages called *thyroid*, which means shield. At the top of each shield we see two little horns to which muscles are attached to suspend the larynx from the hyoid bone, which is the bone of the tongue. You did n't know you had a bone in your tongue ? Well, it does not

go through its length, but supports it at the roots, and also holds up the larynx. Below the thyroid are two cartilages, called the *cricoid*, shaped like a signet ring; that is what cricoid means. On the upper edge of the cricoid at the back are two triangular cartilages called *arytenoid*, which play a very important part in the production of sound. These cartilages have muscles at each corner and are moved by these in much the same way that the triangular metal used in the old-fashioned bell-pull is worked.



THE LARYNX.

Two bands of fibrous tissue are stretched across the larynx from front to back leaving a chink between, and these are the vocal cords. When the air is forced through this chink, it makes the cords vibrate, and sound is

produced. In ordinary breathing, the cords are relaxed, so sound is not made. This orchestrion is like a reed instrument. The vocal cords are the reeds, the lungs are the bellows, and the trachea is a pipe leading from bellows to the voice box. How simple is the construction, yet how complicated the powers of this unique instrument!

Sound, as we have learned, is made by vibrations of air. If these vibrations are irregular, they constitute noise; if they have a certain regularity, they make music. A high note has very quick vibrations; a low note, slow vibrations. Generally, instruments making the same note have different qualities of tone, because of what is called the overtones of each.

Loudness of tone is produced by the force with which air is sent out through the larynx. The cords are made longer or shorter by the action of the triangular cartilages. This determines the pitch of the tone; the shorter and tighter the cords, the faster the vibration and the higher the note; the longer and looser the cords, the slower the vibrations and the lower the note. At about fourteen years of age the larynx enlarges, and the voice changes, becoming lower in tone. Voices of women are higher than those of men because the vocal cords are shorter. Children's

are shorter still, and their voices are correspondingly higher.

The quality of voice is affected by the shape of the throat, mouth, larynx, and trachea, and also by the knowledge of how to use these organs. One can cultivate the habit of talking in a high and disagreeable voice, or in one that is low and soft. The poet says, "A low voice is an excellent thing in woman," and I think he might have said in everybody. The voice marks to a very great degree the cultivation of the individual, and also tells much about his character. The high voice is irritating, and often betokens irritation. People scold in a high voice, and I think I am safe in saying that to be scolded never makes a person want to do better. The low voice tells more of deep feeling, and appeals to the better nature. If you want to arouse all the rebellion there is in a child's nature, talk in a high voice. If you want to move him to good impulses, speak low and soft.

Having in our possession such a magnificent musical instrument, we should learn how to use it not only in singing, but in speaking and reading aloud, using tones that soothe and comfort rather than those that irritate and offend.

The hard palate and nasal passages form a sort of sounding board, and by their vibrations

increase the resonance of tones. We say a man talks through his nose, when, in fact, that is just what he does not do. The so-called nasal tone is made because the nasal passages are closed. The range of the human voice is about four octaves, — that is, from the lowest note of a base voice to the highest note of a soprano. It is seldom that an individual can sing over a range of more than two and a half octaves.

We have only spoken of the production of musical tones. We would like to know something of the formation of speech, and we find that the tongue, lips, cheeks, palate, and pillars of the throat are all used in making vocal sounds, or in modifying the vibrations of air in various ways so as to produce peculiar sounds which we recognize as vowels or consonants, and the union of these forms words. In spoken words, we do not greatly vary the pitch, though we do not talk altogether on one tone, while in singing, we vary the pitch of tones as well as their length, and give them with a rhythm, which we call time. That is, the vibrations are repeated in a certain order which is pleasing to the ear.

Sometimes we find a bodily house in which the orchestrion is silent. The individual is mute. We used to think that was because he had no power to speak. We know now that it is be-

cause the organ of Corti in the inner ear will not respond to Aura when she plays on the drum of the ear. The person is deaf, we say ; and, as he hears no sounds, he makes no attempt to imitate sounds with his vocal organs. He is mute merely because he is deaf. Formerly, the child born deaf was only taught to talk with his fingers, but now he is taught to talk, even though he cannot hear. If he can see, he can learn to read the motion of the lips. If he cannot see, he can learn to read the movements of the lips and larynx with his fingers. Have you not read of Helen Keller, the little girl who cannot see, and yet has learned to talk and hear through her fingers by putting them on the lips and throat of those who are talking to her ? She is a bright, happy, well-educated, little girl in spite of her affliction, and we who can hear and see and speak, ought to thank the divine Architect both with heart and voice.

CHAPTER XXVIII.

THE LIBRARY.

DO N'T you just enjoy a stormy winter day? The wind may howl, the sleet tap on the window-pane with its icy fingers, but it does n't frighten us, for the fire glows cheerily, the big chair beckons invitingly, and all around the walls of the library are books, books, books, waiting to be read; books of travel, of history, of poetry, of romance, the brightest, wittiest, most entrancing thoughts of the great minds of all ages, yours just for the looking at them. What could be more enjoyable? But perhaps your books are not many, only a few dear friends that a slim purse has allowed you to gather around you. They are in plain bindings on a simple pine shelf, but how you love them! They begin back with the friends of your childhood; dear little Dotty Dimple and Prudy Parlin, Robinson Crusoe, Little Lord Fauntleroy, and all the sweet, familiar faces that have not been displaced by the older friends loved just as dearly, Paul Dombey, Little Dorrit, Tom Brown, Robert Fal-

coner, Lorna Doone, Sir Gibbie, and a host of others. How you love the familiar bindings even, and you take them up and caress them as if they knew how dear they were to you, and to part with one of them nearly breaks your heart.

You cannot take your books as you go about your work or play, and yet do you not have them with you? Ah yes, you have stored them away in the library of your wonderful house, a company of dear friends who will ever be with you. You began this library far back in your childhood; and if you have been wise in the selection of authors, you have now quite a collection of literature that you can enjoy at any time or place, or at any hour of the day or night.

Perhaps you have not appreciated this library of yours. When you come to glance over its contents, you see only a higgledy-piggledy collection of scraps. There 's an arithmetic with a part of the multiplication table left out, and — O dear! what a state fractions is in! There 's a grammar with only a few leaves in it, and they are filled with a collection of words which you do n't understand; and the geography! why, in it, the Nile and Niger unite to form the Ohio, New York City has moved over in the State of Rhode Island, and you could not find Abyssinia if you tried all day. The most complete collec-

tion of poems is Mother Goose's Melodies, and there are just a few broken and disconnected verses from the Bible. O, my dear, you really must begin to get things into better shape. What is this big bundle in the corner? Dime novels? I wish you could just take them all out and burn them up. They occupy so much space that ought to be filled with other things. It is one disadvantage of this library that you keep its contents even if you give them away, and the harder you try to forget them, the surer you are to remember them. There is one thing you can do, you can crowd them out. If from this time on you read no more foolish stories, but read good books, interesting and valuable books, gradually this pile of nonsense will fade away and grow dim, and in time, I hope, will vanish altogether.

Now let us see what else you have collected in your wonderful library. Where is your dictionary? O, it 's rather small, is n't it? And now I look it over I see it contains a good many rather queer words, and the spelling seems to be a little unreliable; and here, on this page where you do n't want me to look, are words that make me very sad to see. Let us fasten those leaves together and never peep at those words again. How many good, honest words do you suppose

your dictionary contains? — Not very many. Some people go through life with a vocabulary of only about three hundred words. Your vocabulary means the words which you understand and use correctly.

If you should learn a new word and its meaning every day for a year, your vocabulary would begin to grow very rapidly, would n't it? What would be the use of so many words? It enables us to express different shades of meaning. No two words mean just exactly the same thing. I have heard of a young lady who had only two phrases with which to express her admiration, or her detestation. The things that she admired were "simply perfect," the ones she disliked were "perfectly simple."

If you like something very much, you probably say it is "perfectly lovely," or "awfully nice," and it does not matter whether it is a sermon, a picture, a person, a dinner, or the weather. We like to be rich in money, why not like to be rich in words? Then we should be able to apply our adjectives more appropriately. People sometimes make a very ridiculous use of words. I have heard them talk of "beautiful oysters," an "elegant prayer meeting," or a "handsome piece of music." They had a vocabulary, but they had not studied definitions.

The library of our bodily house will differ in different people. In some, there are great quantities of mathematics; in some the sciences predominate; in some, there are books in French, German, Latin, English, and perhaps half a dozen other languages. Some libraries have many poems, in others there will be scarcely a rhyme. Day by day this library should increase its stores. There are people who seem to see and learn much, yet never store anything away; "they can't remember," they say.

You have already understood that this library is the memory, and the brain is the organ of memory. We have not yet learned just in what parts of the brain different memories are located, though we know where lies the memory of spoken and written words. But we have learned what is of greater value, that even if we don't know just where the book shelves are that contain our memory library, we can find the different books when we want them, and, better still, we can constantly increase their number.

This power of adding to the treasures of memory can be greatly cultivated. We can have good memories or poor ones, in just the same way that we can have strong muscles or weak ones; and that is by exercise or by lack of exercise. Do you not think it would be a fine thing to be

able to remember all the valuable facts with which we have become acquainted? How can you begin this power? First, you must take into account the fact that the material brain is the organ of thought, and to do good work it must have good food, the kind of food that will keep it in repair. Not only must nutrition be supplied through food, but it must be carried to the brain by a good circulation; so, in order to have a good memory, we must exercise with the muscles so as to keep the blood moving; and, to insure a good circulation, the heart must be vigorous — failure of heart power is accompanied by failure of memory.

Then the brain must be exercised. It will not retain impressions unless it is trained to do so, but it must not be overworked. Fatigue, either of body or brain, lessens the power to remember. G. J. Holyoke says of his experience in this line, that when traveling expenses were the only pay he received for his lectures, he used to walk to save railroad fare, and would be so weary in the evening that both voice and memory were weakened, and he did not find out for some years that it was bodily fatigue that had exhausted his power of speech, thought, and memory. Nearly every grown person knows that when very weary he cannot remember even the things he knows

best. Violent exercise, then, should not be taken just before we need to use our brain.

Sickness weakens the memory, and various drugs taken to promote sleep may quite destroy the power of the brain to remember. Age weakens the memory because of failure of nutrition through diminished blood supply. M. L. Holbrook, in his little book on Memory, claims that old people can restore memory by persistently exercising it. His plan is to give everything close attention. To recall at night the experiences of the day, to remember the page of a book whereon an interesting fact is recorded, to commit the names of public men, to learn poetry or the Bible; and he claims that this plan will restore the failing memory of the old. A wiser plan is never to let the memory fail, knowing that to use the brain, to intrust facts to it, to compel it to store up words, names, and incidents will keep it strong and reliable, and make of it a never failing source of wondrous pleasure both to one's self and to others.

Each sense has its own memory. We remember sounds, sights, odors, sensations, and flavors, and if two or more senses are united in retaining the impression, the more distinct it will be. If, for example, we want to gain a clear idea of a new fruit so as to remember and describe

it perfectly, we can do it better if we handle it, look at it, smell of it, and taste it than if we only see it or if we only tasted it without seeing.

Here are a few simple rules for improving or strengthening the memory. First: Never try to learn too much at one time. You will commit a poem faster by learning one line at a time and four lines a day, than you will by attempting to commit the whole poem at once. Second: Understand what you are trying to learn; if you do n't understand, it becomes a collection of words without value. Third: Learn something every day, be it ever so little. Let the brain understand that it must work continually in the storing away of memories. Fourth: Go over your memory lessons often, and, if possible, at regular times to see if you remember them. Fifth: Arrange facts to be remembered in an order that seems naturally to connect them, so that, if possible, one will suggest the other.

Sixth: In quoting, be careful to use the exact words of the author so as to learn with precision and exactness of memory. Seventh: Make abstracts of things desired to be remembered. To write them down, brings in the eye to aid the mind. To remember forms, make a drawing, if possible, for the same purpose. Eighth: In

travel, have a map, and locate on it towns, streams, etc. In reading, recall the location of places mentioned or find them on the map, if not familiar with them, so that you will have an idea of the places where the events narrated occurred. Attention, repetition, and classification seem to be the most important aids to memory.

Mr. Boring likens memorizing to photographing, and says four things are needed in both; a sensitive plate, exposure, a developer, and a fixative. In memorizing, the mind is the sensitive plate; placing before the mind the object to be remembered is the exposure; attention is the mental developer, and repetition the mental fixative.

We have a musical memory which enables us to recall to mind the music that we have heard, or to fix in the memory new pieces of music, so that we can play or sing them without the notes; and the memory of old familiar, songs and hymns becomes a very great source of pleasure as we advance in years.

The library of Memory is one that we must read over and over again whether we will or not, for our memories are really ourselves. If we could forget all our sorrows and pains and recall only our joys and pleasures, we should, in reality, have lost a great part of ourselves, and as we

cannot forget if we would, we will prove our wisdom by reading good books, choosing wise friends, and doing lovely deeds, for these will add not only to the happiness of our earthly life but to the joys of eternity.

As Charles Kingsley says : —

"Be good, dear child, and let who will be clever ;
Do noble deeds, not dream them all day long ;
So shalt thou make life, death, and that vast forever,
One grand, sweet song."

CHAPTER XXIX.

THE PICTURE GALLERY.

MEMORY is not only a library but also a picture gallery. Here are stored away many of the scenes photographed by the eye, or the pictures which at various times, imagination has painted. We begin this gallery in our early childhood, and among the first pictures placed there are pictures of father, mother, brothers, and sisters, the old home, and school-house, —

"The orchard, the meadow, the deep tangled wildwood,
And every loved spot that our infancy knew."

Phebe Cary says : —

"Of all the grand old pictures,
Which hang on Memory's wall,
Is one of a dim old forest,
The dearest of them all."

And we find that the poets make their strongest appeals to our hearts when they are talking of the fond memories of their childhood.

"I remember, I remember,
The house where I was born;
The little window where the sun,
Came creeping in at morn,"

says one. Others sing of "The Old House at Home," "The Old Oaken Bucket," or "The Old Swimming Hole;" and every time they sound a note it puts in motion those tones of influence which set our own heartstrings throbbing. Blessed are we, if, in the retrospect of child-life, we have only beautiful scenes to deck the walls of Memory.

Sometimes, however, there are scenes we would be glad to forget — remembrances of deeds we once did that now make our hearts ache. I have heard of a little girl who was asked by her sick mother to bring her a drink of water, and the child was unwilling, and went away and stayed all day at her play, and came home at night to find that her dear mother had died. What a sorrowful picture to look at during the long, long years to come!

It is sometimes hard to separate the Memory pictures of childhood from those of Imagination. We used perhaps to hear some one often spoken of, and pictured a personality belonging to the name that became as real as if we had actually known the individual. We have heard of some

wonderful deed of our own childhood so often related that we imagine we really remember its occurrence. Then, too, we have illustrated the books we have read with pictures of our own imagination so that they are almost like memory, so real do they seem. You have imagined Robinson Crusoe in his island dress so often that you would recognize him if you were to meet him on the street. And you certainly have been inside the "Old Curiosity Shop," and have seen Little Nell. You remember perfectly well how ridiculous "Alice in Wonderland" looked when she nibbled the cake, and her neck grew so long, and she exclaimed, "Curiouser and curiouser!"

Memory and Imagination are two marvelous artists, ever busy painting for you. Come, draw your chair to the fire, close your eyes, and look at the scenes they delineate. They come like living creatures trooping across your mental canvas, one picture fading away as another comes to take its place. Some bring us smiles, others bring tears, some you would like to look at forever, others you would fain forget; but there they are, coming and going, indelibly impressed on the brain, each day adding to the faces, scenes, and landscapes, a collection continually increasing from birth to death.

CHAPTER XXX.

THE CHAMBER OF PEACE.

WE have learned where, in the brain, lie certain centers of motion, and we are convinced that there are centers of thought and feeling, though we have not yet located them. We ourselves can visit the hidden chambers in this marvelous upper story of our wonderful house, but we cannot tell others where they are to be found, nor may we take even our dearest friends with us into their secret recesses.

Some of these apartments are not very delightful. They may be dark and full of pictures of evil, and it makes us miserable to visit them, and yet perhaps we love to linger in them. They are little alcoves connected with the picture gallery, and we employ an artist called Imagination to paint for us the pictures that adorn their walls.

There is the Chamber of Hatred, and for this Imagination paints dark, forbidding scenes, in which we see ourselves doing unkind things to wound or injure those we do not love, and we

take an evil pleasure in imagining the pain or grief we can cause. There is the Chamber of Envy, and here we sit while Imagination paints the fine carriages and horses, elegant houses, splendid dwellings, and dresses, the beautiful faces and desirable belongings that some one else owns, and we say, "O I wish I owned them!" and then we are very unhappy because they are not ours. To linger long in this room is very dangerous, for sometimes a dark spirit called Temptation creeps in and whispers to us that we might possess ourselves of some of these belongings of others. Theft, murder, and all sorts of crime are planned in this dark chamber. O let us hurry away from the Chamber of Envy and shut the door so tight that the evil temptation will be imprisoned therein never to get out, because we will not open the door.

The Chamber of Selfishness, I think, must be the central room around which all the other dark alcoves are gathered. In this room Imagination paints many strange scenes. He delineates us just as we think we are, and then we fancy that people do not pay us enough attention. He shows us the beautiful possessions of others and contrasts them with our own meager belongings, and we are jealous and unhappy. If we feel moved to do a generous deed and

chance to slip into the Chamber of Selfishness, we at once see a picture of how much trouble it will be and of how little gratitude we will receive in return, so we close the door and stay shut in with ourselves, and then perhaps wonder why we are so unhappy.

There are many dark rooms that we visit, but let us look away from these to the bright and lively chambers wherein Man finds peace and comfort. These charming rooms are alcoves surrounding one central apartment, the Chamber of Love, and here Imagination paints with bright and glowing colors the most entrancing scenes. I picture this Chamber of Love as a circular room with a dome-like roof, azure-tinted, glowing with a soft, ethereal light reflected from the ceiling and from the exquisite pictures upon the walls — pictures in which kindly, unselfish deeds are depicted in all their beauty. How often the faces of father, mother, sister, or friend appear in these scenes! — the faces of those whom we love and for whom it is so easy to do some deed of kindness! But brightest of all are the portrayals of lovely things we have done to some one who has been unkind to us; and as we look, words of golden light gleam out upon the walls and we read, "Love them that hate you;" "Perfect love casteth out fear;" "God is love;" and our

hearts grow tender, and gentle tears fall from our eyes, and we feel inspired with impulses toward all that is holy and best.

And then the doorway opens into the most secret and lovely room of all, the Chamber of Peace, wherein we meet and talk with the spirit of Divine Love. I think this was the room that Jesus was thinking of when he said, "Enter into thy closet, and when thou hast shut the door, pray to thy Father which is in secret; and thy Father, which seeth in secret, shall reward thee openly." He did not mean a closet of the house we have built for ourselves, but he meant a secret room within ourselves, a place where the world can be shut out and we can find rest and peace. I fear we do not seek this room as often as we might, for here are great stores of comfort for every sorrow, of rest in all weariness, of strength in all trial. It does not matter that we do not know just where, in the material brain, this Chamber of Peace is located, we can learn the way thither.

"Too eager I must not be to understand;
How should the work the Master goes about
Fit the vague sketch my compasses have planned.
I am His house — for him to go in and out.
He builds me now, — and if I cannot see
At any time what he is doing with me,
'Tis that he makes the house for me too grand.

"The house is not for me, it is for Him;
His royal thoughts require many a stair,
Many a tower, many an outlook fair,
Of which I have no thought, and need no
care.
Where I am most perplexed, it may be there
Thou makest a secret chamber, holy, dim,
Where thou wilt come to help my deepest
prayer."

— *Geo. Macdonald.*

"Thou who hast made my home of life so pleasant,
Leave not its tenant when its walls decay ;
O Love divine, O Helper ever present,
Be thou my strength and stay."

—*John Greenleaf Whittier.*

PART II.

The Guests Man Entertains in His Bodily Dwelling.

CHAPTER I.

HELPFUL GUESTS.

"A MAN is known by the company he keeps," says the old adage, and I think we can judge pretty well of a person whom we have never seen if we know his company. If he associates with refined, intelligent, Christian people, we can guess that he himself is of the same character. If his friends are dissolute, profane loafers, we know at once that he is not an industrious, moral man. It is also true that a man's house will tell something about him and his companions. When a house shows taste in its construction, neatness and care in its keeping, we judge by these things of the man that owns it, and we quickly form an opinion about him.

The appearance of the body indicates very clearly what kind of guests are entertained therein, for all visitors may be classed under two heads, constructive or destructive. They come either to build up or to tear down, and the effects of their work are seen on the outside of the house. The builders keep him plump and rosy, with

bright eyes, active limbs, and a general appearance of well being. The destroyers make him very pale and thin, or they fill him up with a poor quality of material and make him look too fat. They take the brightness out of his eyes and strength from his limbs. It is therefore very important that Man shall entertain only those who come to help him keep his house in repair, and these are called foods.

Man chooses his own guests but he often invites to his house those that injure him. He does not know their true character. He thinks them friendly because they have a fine appearance, or Taste says he likes them, and so they are invited in over and over again, and do great mischief before he finds them out. If we ought to choose any companions with great care, it should be those who are to come in and dwell with us and become a part of our household.

The first and most important food-guest is Oxygen. He comes in with Aura on her first visit and begins his beneficent work; in truth, Aura comes principally to bring Oxygen, and his business is to cleanse the impure blood from its dark color to the bright scarlet of pure blood. The blood could not do its work in any part of the body if it were not plentifully supplied with oxygen. We are told that a man who is at rest

consumes eighteen cubic feet of oxygen in a day; and, of course, if he is at work, he will take in as much more. Eighteen cubic feet! That would be all that could be held in a room eighteen feet long, ~~eighteen~~ one foot high, and ~~eighteen~~ one foot wide, and remember that this is not air, but oxygen, and that will give you an idea of how important a food it is. It will also show you how necessary it is that the air of rooms and houses should be constantly changing so that oxygen may be renewed, for you will remember that carbonic acid gas is thrown out at each breath and poisons the air. This gas is a deadly foe to health, and, strange to say, is born in the house, in the waste of tissue. It is the business of air in breathing, to bring in oxygen, and to take out the carbonic acid gas. We think it very important that we should eat three times a day, but we sometimes forget that this most important food, oxygen, should freely enter our house eighteen or twenty times a minute.

The second guest brought to our house is a pale, sweet creature called Milk. Although she looks so delicate, and we sometimes sneer at her as being "only food for babies," she is in reality a perfect food, bringing with her everything needed to keep our house in repair. Milk is albumen, sugar, and fat dissolved in water, which

you see makes it ready at once to be easily assimilated; it is especially suited to infants, as they at first have no saliva to digest starch, and cannot appropriate such foods as arrow-root, rice, sago, and such things, which are often unwisely fed to them. After a few months the salivary glands begin to work, and then starches can be digested.

You will remember that the foods are divided into albuminoids, amyloids, sugars, and oils. The albuminoids are also called nitrogenous foods as they contain nitrogen, an important part of the tissues but not contained in all the foods. The most important albuminoid foods are milk, eggs, meat, fish, and grains. Starches, sugars, and fats are also classed as carbo-hydrates, and these are largely found in the vegetable kingdom. They are the foods that make fat, heat, and energy but are not built into tissue. As foods, they are very important but alone will not build up the body. We find these different elements combined in various proportions in different foods, and that is why we need to eat a variety so as to be sure to get all that is necessary to maintain the body in health. Some foods contain the right proportion much more nearly than others.

Milk and eggs are nearly perfect foods though

they contain no starch. Wheat is considered as the standard food. It contains nitrogen and the carbo-hydrates in nearly the right proportion. I mean whole wheat, not white flour, which has too large a proportion of starch, so to eat white bread alone would be to take in too much starch, and it would be necessary to eat something else to supply albumen.

One of the most important foods is water, as the body is itself nearly three fourths water, and a great quantity of the waste material passes out in the form of water. We find that a large proportion of the food that we eat is water, but we need also to drink. It has been stated that the quantity of solid food that an adult man, doing an average amount of work, should take in during one day is twenty-three ounces; the quantity of water, between sixty and seventy ounces. You feel rather inclined to dispute my statement that the body is largely made up of water, but the chemists tell us that even the bones are one-eighth water. Fruits are very important foods because they contain a great deal of water, and also a large amount of salts; I did n't say salt, but salts — that is a term used for the inorganic foods.

We have as yet only talked of the organic foods, that is, those that are formed of living

structures, as plants or animals, but we find in the body other elements called inorganic, which are not found in living structure; these are soda, potash, iron, lime, silica, and so on. These being found in the body, must be supplied in the food. We cannot eat iron, lime, or these inorganic substances in their crude state, but plants can. They take from the soil all these elements and make them over into themselves, and then we get them from the plants; or from other animals that have eaten the plants. If we do not eat foods which contain these inorganic substances in sufficient quantity, we break down. The bones contain a great deal of lime, and if they cannot find it in the food, they become curved and twisted and the body grows out of shape.

Phosphorus is an inorganic substance needed to build up nerves and brain; silica is used in the hair and nails; and when we look about to see where we can find these substances made over for our use, we learn that phosphorus is found especially in the germ of grains, and silica in their outer covering, and this is another reason why we should not bolt our flour, but should leave in it all the elements as they were placed there by God himself. James Russell Lowell says, "Behind the nutty loaf is the mill-wheel;

behind the mill-wheel is the wheat-field ; on the wheat-field rests the sunlight ; above the sun is God."

If we were to invite into our bodily dwelling only those guests which build us up, and these in the right proportion, it is doubtful if we should ever know much about sickness. This being the case, would it not be well to study the matter carefully, not considering merely what tastes good, but what is needed to keep us in repair, and to avoid those things which are destructive ? Great and good men have at all times given thought to the subject of food and have left on record many wise sayings in regard to it. If we knew the value of various kinds of food, we might even cure diseases by selecting a proper article of diet instead of using drugs. Dr. Hunter, a very eminent physician and a sufferer from gout, found apples a remedy, and insisted that all his patients should use apples instead of wine and roast beef. Professor Farrady says, "If families could be induced to substitute the apple (round, ripe, and luscious) for the pie, cake, candy, and other sweetmeats with which children are so often stuffed, there would be a diminution of doctors' bills." Many of the ancient writers have left on record their belief in a simple diet, often entirely discarding animal food.

Socrates says, "To fare well implies the partaking of such food as does not disagree with body and mind, hence only those fare well who live temperately." In ancient Greece the food was plain and simple, and the athletes were trained entirely on vegetable food. We use the word *vegetarian* for one who eats only vegetables, but I have seen it stated that the word is derived from the Latin *vegetus*, which means strong, robust, and hardy, and it is perhaps because vegetable food tends to health that we have come to call those who eat it vegetarians.

It is claimed by those who object to animal food that Milton was a vegetarian, and that Newton wrote his "Principia" while living entirely on vegetable food. It is known that Shelley ate no meat. It is said by Xenophon, that Cyrus, king of Persia, was brought up on a diet of water, bread, and cresses till his fifteenth year when honey and raisins were added. Xenophon also describes the outfit of a Spartan soldier who lived principally on bread and dried fruit. His ordinary outfit weighed seventy-five pounds, which was often increased to a full hundred, and this load was often carried at the rate of four miles an hour, for twelve hours a day, many days in succession; so even if we do not admit that it is best to give up meat eating en-

tirely, we must confess that health and strength can be maintained without meat, and certainly, there is more that is pleasing to think of in the fields of ripened grain, in the fruits hanging from the boughs, than there is in the slaughter of animals.

Ancient Gauls who were very brave and strong lived on milk, berries, and herbs. Their bread was made of nuts, and they had a strange fashion of wearing a metal ring around the body the size of which was regulated by law. If any man grew larger around than his ring, he was thought to be a lazy glutton and consequently was disgraced. Certainly the motto of that people must have been one which would be wise for us all to adopt, "Let appetite wear reasons' golden chain, and find in due restraint its luxury."

CHAPTER II.

SPICY VISITORS.

WHEN I began to speak of foods as visitors to our bodily dwelling, I did not realize how much they are like real folks. We all know people who are plain and unpretending, but so reliable and trustworthy that we value them exceedingly. We are glad to see them every day, and if in need of friends, we call for them instead of our more showy companions. We sometimes say of such a one that he is "as good as gold." The Italians have a better saying, "He is as good as bread," and that is a great compliment. What is better than good, honest, plain bread when we are in need of food? Such constant friends as bread, meat, and potatoes we are glad to welcome every day as helpful guests.

We enjoy occasional visits from people who are very sweet, but if they come too often or stay too long, we get very tired of them. This is true of sweet foods, they cloy the appetite; we can take them along with plainer foods, but

they are a poor dependence for the work of building us up.

Then there are people who are so lively, so clever, their wit is so pungent, their jests so spicy, that their coming stirs us up into unwonted activity, and when they are gone, we say we "just feel all tired out." Such guests sometimes come to our marvelous house. We call them condiments. They are known more particularly as pepper, mustard, spices, sauces, etc. Many people have accustomed themselves to foods so highly seasoned that they cannot enjoy natural flavors, just as people become so fond of society that entertains that they can't enjoy a good, serious, sensible conversation, and that is unfortunate. But these spicy food-guests are, in truth, more to be avoided than spicy people. They are not builders, they are sources of irritation. Mustard on the outside of the body produces a blister, and can you imagine any one blistering himself because he enjoys it? Why then, should he like to irritate in the same way the more sensitive mucous membrane of the mouth and stomach? The same thing may be said of pepper and all pungent, biting substances, they irritate and cause inflammation of the mucous membrane. Every physiology mentions Alexis St. Martin, a man in Canada, who

in 1848 had a wound in his stomach which healed up, leaving a flap of flesh that could be pushed aside, giving a view of the inside of the stomach and what it was doing. Fortunately for science, the doctor who had him in charge was wise enough to improve this opportunity, and because of this we now know, as never before, some of the secrets of our bodily kitchen.

Dr. Beaumont reports that when St. Martin took pepper and other condiments with his food, the mucous membrane of the stomach grew red, just as the eye would if the same substances were put into it. Why do we like them, then, if they are so irritating? I doubt if we do like them naturally. Did you ever see a baby that wanted pepper? I never did. I have seen children two or three years old who would pepper their food, but they did it at first because they saw the older people do it, and after a time they grew to be fond of these things. It is one peculiarity of our bodies that they can soon accustom themselves to very hurtful things and seem to miss them when they are taken away. I once heard of a woman who could not sleep after her snoring husband died unless some one ground the coffee mill in her room, but I suppose none of us would think that an argument in favor of snoring as a lullaby. If the story is true,

which is doubtful, it only illustrates the fact that we can become accustomed to very disagreeable things.

In the case of condiments, such as pepper and mustard, the nerves of sensation complain at first of their biting, but by and by they find complaining does no good, so they keep quiet and finally end by liking to be bitten. It is another illustration of Pope's lines concerning vice. He says : —

> "Vice is a monster of so frightful mien,
> That to be hated needs but to be seen ;
> But seen too oft, familiar with her face,
> We first endure, then pity, then embrace."

So it is with these stimulating substances ; for all condiments are stimulants, and stimulants are things that get more work out of you, without putting strength into you, and that is not desirable. The spices we add to foods do not build up any tissues of the body, but they act like spurs or whips, to excite the nerves and mucous membrane to greater activity. But do they not help digestion ? Science says not. A series of experiments has been conducted by Dr. J. H. Kellogg, at the Battle Creek, Mich., Sanitarium. He gave a breakfast to a healthy young man, and an hour after, by means of a stomach pump, took it away, and had a chemical analysis made

of it to learn the effects of different substances, and he learned that all condiments actually retard digestion.

One fact in regard to condiments, that to me is an argument against them, is that their use must be increased to maintain our enjoyment of them, which is not true of the foods, and this proves that their use deadens the nerves of sensation. This, of course, lessens our power to appreciate delicate flavors. Where the mucous membrane of the mouth and stomach is seared and burned by high seasoning, the bland and ethereal flavor of food as God gave it to us is lost, and so we actually miss the highest enjoyment of eating in our unwise effort to create new pleasures of appetite.

CHAPTER III.

QUESTIONABLE GUESTS.

IT is not a very welcome task to warn people against those whom they believe to be their true friends, but it is sometimes our duty, and therefore should be bravely done. I hope you young people have as yet never made the intimate acquaintance of two foreigners who are frequent guests in the bodily house, although, no doubt, you are very familiar with their appearance. One of them has a dark complexion and is rather bitter unless associated with milk and sugar. His name is *Coffea Arabica* and you know him as Coffee. He was introduced into England and France about two hundred years ago; so if you think people cannot get along without coffee, you have only to study up what was done in France and England in deeds of bravery or in literature, before coffee was ever known.

Coffee is a native of Abyssinia. It found its way into Arabia in the sixth century, and probably as a substitute for wine when that drink was prohibited by the Koran. By the sixteenth

century it had reached Cairo, in Egypt; but here the great men rose up against it, and declared it contrary to the law of their prophet and injurious both to soul and body. Ministers preached against it, and it doubtless would have been abandoned had not the Sultan come to its aid and declared it to be not objectionable. In Constantinople and also in Italy, it met with opposition both from the clergymen and the physicians. Medical science to-day calls coffee a diffusible stimulant, and the testimony of physicians would certainly induce us to be wary of making a friend of coffee. Professor Hitchcock says the bewitching influence both of tea and coffee lies in their narcotic property.

Dr. Bartholow says: "If used to excess, as a beverage, coffee deranges the organs of digestion, producing acidity, flatulence, pyrosis, eructations, headache, vertigo, ringing in the ears, and wakefulness." Dr. Emmet, another authority, says: "I find coffee, even when weak, to exert a very deleterious influence, in consequence of its indirect influence on nutrition. Whenever a patient has become addicted to the use of stimulants, anodynes, or coffee, an effort must be made at once, without a compromise, to break up the dependence upon either of these insidious poisons to the nervous system."

It is sometimes said as an argument in favor of the use of coffee that it is an indirect food because it checks wastes. In the normal healthy body the checking of waste is not desirable. If all the activities of the body are accompanied by destruction of tissue, that dead material should be removed from the body, and any interference with this process must be more or less injurious. A very serious objection to the use of coffee by young people is that it satisfies the desire for food without contributing anything of any great value to the nourishment of the body. Children and young people are continually growing by the addition of new material to their bodily organs, they therefore need to eat plenty of nourishing food, and if coffee satisfies the appetite so that they are inclined to eat less than the body actually demands, it is easy to understand that it is doing the body an injury.

Many people imagine that the powers of intellect are increased by the use of coffee. The testimony of a man with originally good intellect and moral powers as to its effect both upon mind and morals will be of value. "When I awake," he says, "I have the intelligence and activity of an oyster, but immediately after coffee, stores of memory leap, so to speak, to the tongue, and talkativeness, haste, and the letting

slip something we should not have mentioned are often the consequence. Moderation and prudence are always wanting. The cold, reflective seriousness of our forefathers, the solid firmness of their wills, resolutions, and judgment, the duration of their not speedy, but powerful and judicious bodily movements,—all this noble, original impress of our nature disappears before this medicinal beverage, and gives way to overhasty attempts, rash resolutions, immature decisions, levity and fickleness, talkativeness, inconstancy, and rapid mobility of the muscles."

The statement is made that caries of the bones in young children is connected with the use of coffee. It produces also a species of fever sometimes called children's hectic. Their faces become pale, and their flesh soft, and when they have learned to walk, their step is very unsteady, their appetite is feeble, they do not grow naturally, they are apt to be timid, discontented, to sleep badly, are troubled with sore eyes, and their teeth come with difficulty. Increase of heart disease is also, by some physicians, attributed to the increased use of coffee.

The other foreigner is named *Thea Chinensis*, but he is generally known as Tea, and from his complexion designated as Green Tea or Black

Tea. In the quaint diary of Mr. Pepys we find the entry Sept. 25, 1660: "I sent for a cup of tee — a China drink, of which I had never drank before." So we see that until nearly that date tea had been unknown in England; and when people tell us that tea is an assistant in mental work, we can point them to the fact that a good deal of fine intellectual work was done in the world before tea was known. In those days the facts of physiology and hygiene were not known as they now are, and people judged of food and drinks, as many yet do, by their feelings, and, as tea and coffee made them, for the time being "feel good," they very naturally supposed them to be good, and attributed many virtues to them. As we are very desirous of keeping our bodily dwellings in repair, we will certainly be willing to hear frank statements of scientists in regard to tea and coffee.

The Reverend John Wesley leaves on record that he discovered that tea gave him symptoms of paralysis in a shakiness of his hands which ceased when he quit tea-drinking. Dr. Beddoes, of England, demonstrated that a strong decoction of tea is destructive of life, both human and animal. Dr. Beaumont, who had charge of Alexis St. Martin, of whom we have before spoken, observed the effect of tea and coffee upon

the lining membrane of the stomach, and says that their use has a tendency to debilitate the digestive organs. In these statements the doctors are not referring to the effects of adulterations, but to the natural effects of tea and coffee themselves, and these evil qualities are increased by the addition of injurious substances such as indigo, white lead, Prussian blue, etc.

Hot drinks injure the teeth, the gums, the lining of the stomach, and so indirectly the whole system. People who drink much while eating do not chew their food enough, and so do not mix it thoroughly with saliva, and Dr. Beaumont discovered that swallowing food not perfectly masticated produced eruptions and ulceration of the mucous membrane of the stomach. It is said of tea, as of coffee, that it lessens the waste of tissue, and therefore is an indirect food. Of this fact Dr. Page says that to interfere with, or to hinder any of the normal processes of the organism, especially those most vital to the economy, as, for example, that of the constant breaking down and excretion of tissue, is not only to invite disease, but the impairment of those functions constitutes disease.

Professor Albert B. Prescott, of the University of Michigan, who, as a chemist, has investigated the properties of tea and coffee, says that the

caffein of the one and the *thein* of the other are built on the chemical type of the alkaloid, a class of bodies which nature forms in plants but not in food-plants. This class of bodies includes narcotics, stimulants, hypnotics, deliriants; poisons, which either excite or depress the nervous system.

Dr. Richardson, a physician and great scientist, asserts that the misery of the women of the poorer classes of England is more than doubled by the use of tea. Dr. Ferguson, an eminent physician studying the effects of tea and coffee upon the health and growth of children, says that children allowed these beverages average a gain of four pounds a year between the ages of thirteen and sixteen, while those who were given milk instead, average fifteen pounds a year gain in the same period. Is not all this testimony sufficient to make us, who have not yet made the intimate acquaintance of these two foreigners, say we will not put ourselves into the power of companions who bring us nothing of good but are so powerful to do harm?

CHAPTER IV.

TREACHEROUS COMPANIONS.

A FRIEND who fails, out and out, to keep his promise is one who cannot injure us greatly, for we soon learn to distrust and avoid him, but one who makes us believe he is keeping his promise to help us, while, in truth, he is all the time secretly injuring us, is the one who can do us the greatest harm because of our confidence in him.

If you employed a man as a special guardian of your house, and he promised to take care of the premises while you slept, and then he should take advantage of your trust, to undermine the foundations, to break the windows, to tear down the electric wires so that you could receive no word of the mischief he was doing, he might, in truth, be called a false friend, and you ought to feel grateful to any one who would inform you of the true state of affairs and warn you against trusting one so unworthy. It is such a note I would now sound in your ears, warning you against a class of visitors who will make wonderful promises of assistance; but, if allowed to

become your guests, will work great mischief. They all come promising to add to Man's comfort, to make him forget his cares, to help him to sleep, and to close the complaining mouth of Pain, whom Man so often fails to recognize as a friend.

Perhaps the most widely known among these false friends is Opium, a dark, unpleasant-looking creature whose influence over Pain is very remarkable, and it is scarcely to be wondered at that Man receives him with a hearty welcome when he once learns how quiet Pain becomes under the influence of Opium, but when we learn the method by which Pain is stilled, we find it not desirable. We know that Pain's complaint means that something is wrong about the house, and we should seek to know what is wrong and right it, then Pain will subside of his own accord. But Opium throttles Pain, as it were, and prevents his making complaint; or more truly, he paralyzes the nerves of sensation so that the messages of Pain are not received at the General Office, and the mischief of which he is complaining goes on uncorrected. Because he hears no more grumbling, Man imagines that everything is as it should be. After a time, the paralyzing influence of Opium passes away, and then Pain renews his complaint more loudly, and

Man, in his agony, again calls on his false friend to come to his aid. In this way he becomes a slave to Opium, and the bodily house is thrown into such a state of revolution that it is only when the tyrant Opium reigns through his paralyzing power, that Man has any peace.

The habit of opium using in various forms, as laudanum, morphine, or opium smoking, may be called intoxication, from a Greek word *toxicon*, meaning poison. All these false friends are poisons, and they all work in the same fashion by creating such a demand for their presence that they become tyrants, and Man their slave.

The poet Coleridge, who for many years was addicted to the use of opium, says, "My case is a species of madness, only that it is a derangement and utter impotence of volition and not of the intellectual faculties. You bid me rouse myself. Go and bid a paralytic in both arms to rub them briskly together and that will cure him. 'Alas,' he would reply, 'that I cannot move my arms is my complaint and misery.'" I am glad to tell you that Coleridge, after a fearful struggle, was freed from the dominion of opium. De Quincy, who was also an opium slave but who freed himself from the tyrant, says, "I triumphed, but think not that my sufferings were ended. Think of me as one, who,

even when four months have passed, is still agitated, writhing, throbbing, palpitating, and shattered."

The use of opium affects not only the physical system but the moral nature. Dr. Kerr, who has made a very thorough study of the effects of narcotic poisons, says that under their use, love is transformed into hate, and the one who uses them, often loathes the sight of those whom he used to cherish with the tenderest affection. He continues: "Opium transforms the manly, high-toned, pleasant companion into an effeminate, driveling, querulous bore. It transcends alcohol in the generation of a more irreclaimable and incurable diseased condition. Cured alcohol-inebriates are not uncommon. Cured opium-inebriates are comparatively few in number. The perception is so clouded that they are not amenable to intellectual and other elevating influences."

Another false friend, not much over twenty years old, is Chloral Hydrate, whose chief attraction is his power to produce sleep, but he accomplishes this only by utterly destroying the ability to sleep. He interferes with digestion, oppresses the heart, disturbs circulation, and affects the work of the nervous system. Chlorodyne and Chloroform are relatives of Chloral Hydrate, and

their effect is similar in the deadening of sensation and the working of mischief while Man is unconscious. Cocaine may be included in this list. This is a powerful drug, and, like those before mentioned, may have a valuable work to do in the hands of a skilful physician, but, if taken at the will of the individual, soon becomes a tyrannical master who caresses only to destroy. Its first effect is a feeling of increased mental and bodily power, but sleeplessness and depression and a train of direful evils follow, and the ultimate tendency is to produce delirium and raving madness. Absinthe and Haschish are friends of this character, better known in foreign lands than in our own. We must not forget to mention ginger as of this class. It is usually associated with alcohol before its use becomes a slavish habit, and so united, it becomes destructive to the stomach and causes a persistent gnawing feeling through depraved mucous membrane and nerve disturbances. These ginger extracts are usually purchased by women who perhaps have little idea that they are becoming drunkards by their use.

When we remember that only those substances which contain the material to rebuild the body can truly be called foods, and that these are the only substances that should be

taken regularly into the system, we have a guide in our choice of visitors to our bodily house, and if we are truly wise, we will refuse admission to those whom we do not know to be builders. We could very well put up with the tearing down of our dwellings by carpenters who were preparing to rebuild it, but we would have little patience with a troop of boisterous invaders who would tie us fast while they destroyed our most precious possessions. We should be equally impatient with such false friends as we have described in this chapter, and utterly refuse their admission to our bodily dwelling.

CHAPTER V.

A DECEITFUL FRIEND.

AMERICA has the responsibility of introducing to the world one who has become an intimate companion of both the high and the lowly. Tobacco has held his place in spite of his objectionable appearance, and in spite of the fact that his first introduction into the body is usually accompanied by serious upturnings. He is so universally disagreeable to every member of the household that all unite in a desperate effort to get rid of him ; an effort so terrible, in truth, that during the struggle the whole contents of the kitchen may be emptied out of the front door, all the guardians and servants be greatly disturbed in their duties, and work in most parts of the house be temporarily suspended. This most unpleasant visitor has a dark complexion, and carries with him an evil odor that ought to forbid his admission into any respectable household. He comes of a low family. The deadly Nightshade, the Horse Nettle, Jamestown Weed, and Henbane are near relatives of his ; but, like

some other bad folks, he has some relatives who are beautiful, such as the Night-blooming Jasmine; or useful, as the Potato and Tomato who are his second cousins.

Are you now willing to learn what Science says of Tobacco? We feel obliged to accept the statements of Science, for they are records of facts, and are not in the interest of any theories of reform. Scientists study the body and set down just what they find, letting it prove or disprove what it may, and they have been interested in investigating the effects of Tobacco in the various disguises in which he enters the house.

Sometimes he comes dressed in white and looks very dainty, and in this form is called a cigarette, and to many he appears as if quite harmless. Little boys are often most anxious to make his acquaintance, and sometimes become so fond of him that they say they cannot give up their friendship with him. Yet even in this charming guise he is black at heart and does most destructive work in the house. He often brings with him the false friend Opium, and frequently the white paper in which he is wrapped is bleached with arsenic. Tobacco always carries with him a deadly poison known as nicotin which is found as an oil, and it is said that this

oil is seven per cent of the whole weight of the tobacco leaf. And what does nicotin do? "Nicotin primarily lowers the circulation, quickens the respiration, and excites the muscular system, but its ultimate effect is general exhaustion. Administered in the minutest doses, the results are alarming, and in larger quantities will occasion a man's death in from two to five minutes." This, of course, means the pure nicotin separated from the other substances in the tobacco. Well, I, for one, do not want anything to do with a visitor who steals into my house to do such harm as that, do you?

Franklin found that if tobacco smoke were passed through a stream of water, oil would appear on the surface, and that oil applied to the tongue of a cat would kill it, for that oil was nicotin. You wouldn't drink water through which tobacco smoke had passed, you say. Of course not, but you often have to breathe air that is filled with it, for the nicotin goes off with the smoke, and not only the smoker, but everybody around him suffers.

Tobacco sometimes comes as a visitor to the bodily dwelling in a brown dress as a cigar; or he may be carried in a conveyance called a pipe, and some men spend more time and take more pride in coloring a meerschaum pipe by

tobacco smoke, than they do in gaining a profession, so we see what a noble ambition it stimulates. Occasionally we find a person who takes Tobacco into closer companionship, and invites him into the reception room, rolls him over in familiar association with his tongue, presses him between his teeth, and then casts him out. This chewing is the most disgusting form of friendship with Tobacco, and is particularly hurtful in that it puts a great deal of unnecessary labor on the salivary glands, and then throws the result of their labor away. The man will not swallow the tobacco poisoned saliva but keeps constantly spitting, and this wastes a valuable digestive fluid.

Snuff-taking used to be quite fashionable. In this habit, tobacco in the form of a fine powder is taken into the nose. Very few people snuff now-a-days, yet in the South we find it used by women who dip a stick into the snuff and then chew it. Some people claim that tobacco is good for the teeth, but the testimony of many dentists is to the effect that while it may deaden pain, it hastens decay.

Although Tobacco is not allowed to penetrate farther than the reception room, his poisonous influences are felt all through the house. His first influence will be on the lips, tongue, and

throat, and serious irritations or even cancers may follow. The cancer of Senator Hill is said to have been the result of smoking, and it is the general belief of physicians that the frightful throat difficulties of General Grant and the Emperor Frederick were in a great degree the result of smoking. Doctors who have had the opportunity of observation easily recognize the smoker's sore throat.

All users of tobacco will recall their first experience and admit that it has a serious effect upon the stomach.

Tobacco smoke necessarily irritates the bronchial tubes and lungs, which were made to deal with pure air, and not with that poisoned with nicotin, and serious lung affections are caused or greatly increased by smoking. One of the famous Delmonico brothers of New York used to smoke a hundred cigars a day, and died from a morbid enlargement of lung cells that caused fits of coughing that nearly strangled him.

The effect of nicotin on the blood is to make it watery and change the red corpuscles so that they rapidly go to pieces, and the ratio of degenerated corpuscles may go as high as one to ten healthy ones. This condition of the blood is shown by the microscope. A man who had been selecting a microscope, left on the slide a

drop of his own blood which he had used as a test. A professor of microscopy saw the slide and said to the dealer: "Tell that gentleman, if you can without impertinence, that unless he stops smoking at once he has not many months to live." A few weeks later he died, and the doctors called his disease a "general breaking-up." A Cincinnati paper tells us that at one time the sister-in-law of General Sherman was ill and it was thought that transfusion of blood might save her life. Blood was therefore conveyed to her arm from that of her son, an apparently vigorous young man, but a great smoker. In a few moments she exclaimed, "Who is smoking? I taste tobacco." No one was smoking, but the small amount of blood drawn from the veins of the young man was so saturated with tobacco that it had been recognized by her sense of taste. She died shortly after with heart failure. This gives an idea of the effects of tobacco in poisoning the blood, and explains how it interferes with the growth of the young. Children grow only by having good blood carried to all parts of the body. If one tenth of the blood is made of broken-down blood cells, it cannot build up strong nerves, muscles, and bone, and so the smoking boy may not grow to full size. This lack of growth does not result alone from a poor

quality of blood, but from the debility and irregularity of the heart's action, caused by the nicotin. Brodie says: "It powerfully affects the action of the heart and arteries, producing invariably a weak, tremulous pulse, with all the apparent symptoms of approaching death."

Another physician says: "If we wish at any time to prostrate the powers of life in the most sudden and awful manner, we have but to administer a dose of tobacco and our object is accomplished. The effect on the heart is not caused by direct action, but by paralyzing the minute vessels which form the batteries of the nervous system. The heart, freed from their control, increases the rapidity of its strokes, with an apparent accession, but real waste, of force."

Under its influence the heart beats more rapidly, but not with the same force, so it does not send a constant stream of blood to all the organs, while at the same time it is exhausted by its own increased labors. If we go back and read the chapter on the Force Pump, and see that the heart must get its rest between beats, and then are told that one doctor who counted his pulse every five minutes during an hour's smoking calculated that it beat a thousand times too often, we can begin to realize the danger to the heart

in the use of tobacco, and will not be surprised to learn that "the tobacco heart," as it is called, is on the increase, and many young men are finding untimely graves through making a friend of tobacco.

Dr. Magruder, medical examiner of the U. S. Navy, says that one out of every one hundred applicants for enlistment is rejected because of irritable heart from the use of tobacco. Major Houston, of our naval schools, asserts that one fifth of the boys who apply for admission are rejected on account of heart disease, and that ninety per cent of those thus rejected have induced the heart disease in themselves by the use of tobacco.

The deteriorated blood caused by its use has its effect upon the nutrition of all structures, but it has also a direct effect on the nerves, paralyzing those of sensation and of volition. Dr. Newell, of Boston, says, "Tobacco has eleven special centers of action in the human system, the chief of which are the heart, eyes, spinal cord, genitalia, lungs, and the circulation. I have seen nicotin lower the circulation and lessen the respiratory power, wither and paralyze the motor column of the spinal cord, produce atrophy and blindness. It produces mental

aberration, low spirits, irresolution, the most dismal hypochondria, insomnia, and sometimes, after the victim has retired, frightful shocks, like a discharge of electricity." What do you think of such a friend as that?

Do you know that athletes, oarsmen, and pugilists are not allowed to use tobacco, and can you guess why? It is because they have learned that they cannot do their best work when they smoke. Mr. O' Flaherty says: "I have known men who, previous to their using tobacco, could send a bullet through a target at eight hundred yards, but after they became smokers were so nervous that they could scarcely send one into a hay-stack at a hundred yards." The hand of the smoker often trembles so that he cannot draw a clean, straight line, and it is said that applicants for the situation of bookkeeper have been rejected because of their tremulous handwriting. Our base-ball players are learning that the man who uses tobacco may have a defective eyesight which lessens his ability as a batter. The use of tobacco causes a dilatation of the pupils of the eye and confusion of vision. They find too frequently that when they shut their eyes the images remain visible a long time because of the impaired activity of the nerves of the retina. A peculiar kind of blindness is at-

tributable to the use of tobacco, which will not be relieved by any remedies as long as the habit of smoking is continued.

One doctor says that tobacco produces a contraction of the blood vessels which causes anæmia of the nerve structure, and this, of course, weakens the nerves and causes them to degenerate. The ear is also affected by the use of tobacco. Sometimes there is an inability to hear clearly, and sometimes there are roaring sounds in the ears. In other cases there will be chronic catarrh and inflammation of the middle ear, extending down the Eustachian tube into the throat. Actors and singers are learning by experience that the use of tobacco injures the voice, rendering it coarse, tremulous, and husky.

The effect upon the brain and nerves is very marked. A member of the Paris Academy of Medicine says that statistics show that in exact proportion to the increased consumption of tobacco, is the increase of diseases in the nervous centers, insanity, general paralysis, paraplegia, and certain cancerous affections.

The Superintendent of the Pennsylvania Insane Hospital says: "The earlier boys begin to use tobacco, the more strongly marked are its effects upon the nerves and brain." Professor Kirke says: "You see a man weary, and yet

restless. By means of the narcotic this nervous irritation is subdued. The supply of vital force from the organic centers to the motor nerve is so much lessened that the irritating movement in them ceases. This gives a sense of relief to the person affected. He is not aware that the benefit is purchased at a very serious cost. He has not only lessened the supply of vital force for the time being, but has done a very considerable amount of injury to his vital system. He has, in fact, poisoned the springs of life within him. As soon as these nerves rally from the lowering effect of the narcotic, the irritation returns, and the narcotic is called for anew. Fresh injury is inflicted for the sake of the ease desired. This goes on till the vital centers, if at all delicate, totally fail to give supply to the motor nerves, and paralysis begins. Yet the man goes on indulging in the so-called luxury of the narcotic."

Physicians are even beginning to ascribe delirium tremens to the exasperating agency of tobacco upon the human nerves and organism, but the evil effects of tobacco are not confined to the phyiscal powers but are also felt in the intellectual capacity. Presidents of colleges, superintendents of schools, educators everywhere are giving their unqualified testimony upon this point.

In 1863 the Emperor Louis Napoleon, learning that paralysis and insanity had increased with the increase of tobacco revenue, ordered an examination of schools and colleges, and this brought to light the fact that the average standing both as to scholarship and character, was lower among the users of tobacco than among the non-users, and he therefore issued an edict forbidding its use in all the national institutions.

French medical scientific men made very thorough investigation in regard to the effects of tobacco in the public schools of France, extending from 1876 to 1880, and the result was that the minister of Public Instruction issued a circular to teachers in all schools of every grade forbidding tobacco, as injurious not only to the physical, but to the intellectual development.

I heard a president of a Normal College say to his students that he could pick out the users of tobacco by simply looking at the record of recitations, and added: "If there is one boy who can use tobacco and keep up with his classes, that boy has an intellect bright enough to yield him a world-wide reputation if he were to give up the use of tobacco." The *Yale Courant* tells us that in the four grades of scholarship into which Yale students are divided, in the first grade, only twenty-five per cent use tobacco; in

the second grade, forty-eight per cent; in the third, seventy per cent; and in the lowest, eighty-five per cent. A report by the medical department of the U. S. Naval Academy at Annapolis, Maryland, enumerates as the results of the use of tobacco in the school: "Functional derangements of the digestive, circulatory, and nervous systems, manifesting themselves in the form of headache, confusion of intellect, loss of memory, impaired power of attention, lassitude, indisposition to muscular effort, nausea, want of appetite, dyspepsia, palpitation, tremulousness, disturbed sleep, impaired vision, etc., any one of which materially lessens the capacity for study and application. The Board are of opinion, therefore, that the regulations against the use of tobacco in any form cannot be too stringent." What an array of charges to bring against one who claims to be a friend!

Worse, perhaps, than all this terrible effect on the body and mind, is the evil result to the moral nature. According to a New York doctor, "the universal experience of all mankind will attest, and the intelligent observation of any individual will confirm the statement that, precisely in the ratio that persons indulge in narcotic stimulants, the mental powers are unbalanced, the lower propensities acquire undue

and inordinate activity at the expense, not only of vital stamina, but also of the moral and intellectual nature. The whole being is not only perverted, but introverted and retroverted. Tobacco using, even more than liquor drinking, disqualifies the mind for exercising its intuitions concerning the right and wrong; it degrades the moral sense below the intellectual recognitions."

The testimony of Professor Stuart, of Andover, is that tobacco undermines the health of thousands, creates a nervous irritability, and thus operates on the temper and moral character of men. It is the opinion of Professor Mead, of Oberlin, that the tobacco habit tends to deaden the sense of honor as well as of decency, and none are likely to practice deception more unscrupulously than those who use the weed.

Dr. Harris says, "There is no article of luxury that so secretly, and yet so surely saps all the foundations of manliness and virtue as the use of tobacco. It paves the way to every vice, and tends directly to habits of the grossest immorality.

We can only account for the enslavement of moral teachers to the habit of smoking, on the ground that these men began the habit years ago when the true character of tobacco was not as well known as to-day, and now, blinded by

its seductiveness, they will not be convinced that it has harmed them. I think one of the saddest sights I ever saw was that of two doctors of divinity smoking together, one fast falling into imbecility with softening of the brain, and the other totally blind. The profession of piety does not save one from the penalty of violated law, and it is written, "Whoso defileth the temple of God, him shall God destroy, for the temple of God is holy, which temple ye are."

In a discourse to the graduating class at Williams College, President Hopkins, after some preliminary remarks on the use of tobacco, thus sums up: "I may express to you my conviction that habitual narcotic stimulation of the brain is not compatible with the fullest consecration of the body as a temple of God. Good men may do this in ignorance, as other things prevalent at times have been done, and not offend their consciences; but I believe that greater earnestness, more self-scrutiny, fuller light, would reveal its incompatibility with full consecration, and sweep it entirely away. The present position, on this point, of the Christian Church as a whole, and largely of the Christian ministry, I regard as obstructive of the highest manhood and of the spread of spiritual religion. I know that strong men have in this connection been bound as in

fetters of brass, and cast down from high places, and have found premature prostration and a premature grave, and that this process is now going on. Let me say, therefore, to those of you who expect to be ministers, that I believe sermons, even those called great sermons, which are the product of alcoholic or narcotic stimulation, are a service of God by 'strange-fire;' and that for men to be scrupulous about their attire as clerical, and yet to enter upon religious services with narcotized bodies and a breath that 'smells to heaven' of anything but incense, is an incongruity and an offense, a cropping out of the old pharisaism that made clean 'the outside of the cup and platter.' Not that abstinence has a merit, or secures consecration; it is only its best condition."

It is claimed by many that the use of tobacco leads to strong drink. To be sure, many smokers do not drink, but I imagine there are few drinkers who do not smoke, and the testimony of men endeavoring to reform is that to succeed they must not only give up their drink but their tobacco.

Alcohol is often used in the process of curing the tobacco leaf, so, in addition to the poison of nicotin, the user of tobacco may also take in some alcohol with it. Jerry Mc Auley, well

known for his mission in Water Street, New York, said that it is rare to find a reformed man who does not return to his cups, if he continues the use of tobacco, and the effort is made in his mission to induce men not only to give up drink, but the use of the weed as well. The fetters which tobacco binds around his victims are as strong as those of opium or alcohol.

I once talked with a boy of seventeen, who said he could have a good farm given to him if he would quit smoking. "I want the farm," he said, "and I have tried to quit, but I cannot." I have even heard of a boy of six so enslaved by the tobacco habit that he preferred a cigarette to candy.

I find in the book, "Tobacco Problem," this little story: A man found himself out of flour, meat, and tobacco. Having in his purse only a dollar and seventy-five cents, he went to market and came home with fifty cents' worth of meat, and the dollar and twenty-five cents' worth of tobacco, telling his wife that they must trust the Lord for flour. If grown men are such slaves, would it not be wise for boys to keep out of such bondage? I wish they could be induced to say that they were free, but alas! all over our land boys are beginning to put themselves into the power of this tyrant.

The Boston *Journal*, in the year 1882, says, "Seventy-five per cent of school boys over twelve or thirteen years of age, smoke cigarettes." We are glad to learn that Professor William Stephenson, Philadelphia, has caused to be pasted in the inside of every text-book used in his school, a brief, printed statement of the physical and mental diseases produced in the young by the use of tobacco. It needs backbone to give up the habit of tobacco using, and many people are afraid to quit suddenly for fear the results will be serious, but we have the testimony of medical men to the fact that, while it may be exceedingly uncomfortable, it is perfectly safe to quit immediately.

Dr. Kirkebride says, "I have never seen the slightest injury result from the immediate and total breaking off the habit of using tobacco, and the experience of this hospital is a large one in this particular." We quote, from the testimony of another physician: "The struggle of the sufferer may be terrible, he may even feel like death, but there is no danger of dying. Such a result has never yet happened. Although the pain and misery are intense, their duration is short."

To one endeavoring to break free from the fetters of tobacco using, it might be well to sug-

gest that a great assistance will be found in avoiding all stimulating, highly seasoned articles of food, and in the using of fruits, especially lemons, also in warm bathing, or wet sheet packing, to induce the speedy elimination of the poison from the skin.

I have written as if all the victims of the tobacco habit were men and boys, but I am told that girls are often induced to smoke cigarettes just for fun, and end by becoming constant users of tobacco. I know of one bright girl of seventeen who smokes so much that she carries with her the same odor of person as a tobacco-saturated man. What a frightful thing for a pretty girl to poison the air all about her with the odor of tobacco, and yet it is no worse for girls to smoke than for boys, and we who have come to have a regard for the bodily house in which we dwell in company with the divine Architect who created it, will certainly banish tobacco from our premises.

The Bible says, "When a man would build a house, he first sits down and counts the cost." It is well also to count the cost of bringing into our wonderful house agencies which will tear it down. We have been counting the cost of the use of tobacco in its effect upon nerves and blood, on heart and brain, on memory, in-

tellect, and morals; now suppose we count the cost in dollars and cents. You can figure up for yourself what would be the yearly expense of a man who smoked a hundred cigars a day, as Delmonico is said to have done. If they cost only five cents apiece, it would amount to five dollars a day, or eighteen hundred dollars a year.

A man is considered a very moderate smoker who uses only three cigars a day; computing these at five cents each, would make over fifty dollars a year. But suppose he only spends five cents a day, will you figure up what he could save if he put it out at compound interest? Or suppose he put the fifty dollars into books, at the end of a year he would not have paralyzed his nerves and poisoned his blood, and have only an empty pocket-book; he would have gathered about him a company of choice friends to be a pleasure to him all through life.

Let me quote again from "The Tobacco Problem:" "Some years since, the annual production of tobacco throughout the world was estimated at four billion pounds. This mass, if transformed into roll-tobacco two inches in diameter, would coil around the world sixty times; or, if made up into tablets, as sailors use it, would form a pile as high as an Egyptian

pyramid. Allowing the cost of the unmanufactured material to be ten cents a pound, the yearly expense of this poisonous growth amounts to four hundred million dollars. Put into marketable shape, the annual cost reaches one thousand million dollars. This sum, according to careful computation, would construct two railroads round the earth at twenty thousand dollars a mile. It would build a hundred thousand churches, each costing ten thousand dollars, or half a million school-houses, each costing two thousand; or it would employ a million of preachers and a million teachers, at a salary of five hundred dollars."

It is estimated by a computation from internal revenue tax paid in the fourth district of Michigan, that the consumers of tobacco in that district, in one year paid out ten times the amount it costs per annum to support the University of Michigan and its students.

The late President Wayland says: "The American Board, an institution of world-wide benevolence, which collects its funds from all the Northern States, does not receive annually as much as is expended for cigars in the single State of New York. But this is not the only expense of tobacco using. Great fires often result from the carelessness of smokers. A plumber threw

down a lighted match in the printing establishment of Harper Brothers; a fire resulted with a loss of two million dollars, and about two thousand people were thrown out of employment. A fire which destroyed three million dollars' worth of property resulted from the throwing away of a half-smoked cigar. A young woman was riding with a young man who was smoking; a spark from his cigar set fire to her light muslin dress, and she was burned to death.

The destructive effects of tobacco-raising on the soil, must be included in this count of cost; also its effects upon the condition and character of those raising it. Jefferson says, "It is a culture productive of infinite wretchedness. No other crop so entirely exhausts the soil, and this must be recognized by those who travel through the old tobacco-growing districts." Close observers declare that the cultivation of tobacco tends to blunt the moral and religious sensibilities, impairs the spiritual perception, and results in many cases in spiritual death. If tobacco lessens courage, decreases will power, diminishes mental force, and deteriorates bodily vigor, its constant use, as in our country, cannot fail to be manifest in the characteristics of the nation.

Extract from the *Quarterly Journal of Science*, 1873: "Homer sang his death song, Raphael

painted his glorious Madonnas, Luther preached, Guttenburg printed, Columbus discovered a New World before tobacco was heard of. No rations of tobacco were served out to the heroes of Thermopylæ, no cigar strung up the nerves of Socrates. Empires rose and fell, men lived and loved and died during long ages without tobacco. History was for the most part written before its appearance. 'It is the solace, the aider, the familiar spirit of the thinker,' cries the apologist; yet Plato, the divine, thought without its aid, Augustine described the glories of God's city, Dante sang his majestic melancholy song, Savonarola reasoned and died; Alfred ruled wisely without it. Tyrateus sang his patriotic song, Roger Bacon dived deep into nature's secrets, the wise Stagirite sounded the depths of human wisdom, equally unaided by it. Harmodius and Aristogeiton twined the myrtle round their swords, and slew the tyrant of their father-land, without its inspiration. In a few words, kings ruled, poets sang, artists painted, patriots bled, martyrs suffered, thinkers reasoned, before it was known or dreamed of."

CHAPTER VI.

THE FOE OF THE HOUSEHOLD.

I ONCE invited a lady to visit me in my new house which had been built after my own plan, and was very dear to me. She brought with her a little son of five years, and he had a most enjoyable time even if I did not. He made pictures on the windows with moist fingers, he swung from the door knobs, kicking the paint with his heels; he drew pictures on the dainty paper with a pencil; and, finally, lay down on the floor and pounded with his heels on the wall, to enjoy the noise, I suppose. I had quietly submitted to the soiling of windows and paper, but I could not sit still and see the plastering broken, and so gently remonstrated. The mother, who had been a most placid witness of her darling's devastations, now felt it necessary to utter a mild remonstrance. "O my dear, you must n't play that way in the house." The young hopeful gave another tattoo with his heels, saying, "What are houses made for then?"

When I have seen the evident delight taken by people in the wilful destruction of their

bodies, I have thought that, like this child, they imagined their bodily houses were made to destroy.

There is one guest who is as destructive, though not as frank a visitor as this child. Like the other false friends whom we have described, he claims to build up while in reality he is only pulling down. He poses as a royal individual under the title of King Alcohol, and many of his subjects do him loyal homage. Although claiming the title of royalty, he proffers invaluable service. He says, "Admit me to your house and I will add to its powers and increase your happiness. I will give you added digestive force, and increase your mental ability and muscular vigor; I will enable you to endure cold, hunger, and hardships; I will cure your diseases, quiet your pains, and comfort you in your sorrow." No wonder that with such promises he was believed to be a veritable savior from manifold ills, and, as such, was received in the palaces of the rich and the cottages of the poor with a right royal welcome.

And how has he kept his promises? For a long time it was supposed that he actually did all that was claimed for him; songs were sung in his praise, and in homes and hospitals, in health and disease, accidents and emergencies,

he was thought to be the one unfailing reliance.

Before we study his deeds, let us learn a little of his personality. The forms under which he asks admission to the bodily house are many. Sometimes he comes as a right jolly, commonplace fellow called Beer, who hobnobs with those whose purse is slim and whose tastes are for ordinary pleasures. Sometimes as Cider he claims to be the companion of rustic enjoyments. To the more refined and fastidious he presents himself as bright, sparkling Wine, that claims only to exhilarate and enhance the joys of life. Sometimes in guise of Brandy, Whisky, Gin, and the like, he makes a sharp appeal to the senses, and more quickly deadens the sensation of discomfort.

Science, in her investigation, has learned that decomposition is taking place constantly; that substances are changing their forms, but that in all the change nothing is lost. All organized substances undergo the form of decomposition called decay, and the decay of the same substance under different circumstances gives rise to different products. Nitrogenous compounds decay very readily. Pure starch and sugar will keep a long time, but brought into contact with nitrogenous products in the process of decay, they take on the same condition.

We know that one decayed apple in a basket will very soon spoil all the rest, and we are not very fond of rotten fruit. This process of decay produces what is known as fermentation, where the atoms that have united to form the substances are returned to their original elements of carbonic acid and water. They are putrefying, and every putrefying substance becomes a ferment, and can start fermentation in other substances.

It is now conceded by scientists that in all these processes of decay, living organisms are present. Yeast is produced by fermentation of starch, and is found to consist of a live fungus. In the production of alcohol there must be five things: First, sugar; second, water; third, heat; fourth, a ferment; and fifth, atmospheric air. The juices of vegetables and fruits contain sugar and water; these exposed to the air in a warm place ferment and produce alcohol.

All grains have a great deal of starch which can be changed into sugar. In the sprouting of all seeds a peculiar ferment called diastase is produced. When grain that has sprouted is killed by hot water and allowed to stand a short time, this ferment increases and thus produces what is known as malt, which added to another grain and kept moist and warm, will change its

starch into sugar, and then the fermentation takes place which produces alcohol.

You see that in order for alcohol to exist, the sweet, nourishing grain must die and rot, and all its health-giving properties be destroyed. Beer is made from fermentation of barley ; wine is the fermented juice of grapes or other fruits ; hard-cider is the fermented juice of apples. By the action of heat, alcohol is driven off from these fermented liquors, and this is called distillation. In the process some water goes off with the alcohol and thus is formed various strong liquors, such as brandy or whisky, which are one half alcohol. Some wines are one fourth alcohol, others not more than one twentieth ; cider is, perhaps, one fifteenth.

We see that in the formation of alcohol, there is always a destruction of sugar. It never arises from growth, but always from decay, and decay assisted by an artificial process. As Count Chaptal says, "Nature never forms spirituous liquors ; she ripens the grape upon the branch, but it is art which converts the juice into wines." Hargreave's book, "Alcohol and Science," says : "No chemist has ever yet found alcohol among the substances formed by plants. Nature in the laboratory of vegetation, takes the poisonous gases and splits them up, and then puts the

atoms into new groups capable of nourishing the animal system. But alcohol is a product of dissolution, the wreck, the disorganization of human food ; it is, in reality, a product of decomposition. The juices of the fruits, by the influence of that fungus yeast, are turned into rottenness, and then, and then only, is alcohol generated out of the destruction of the organic sugar. It has the same origin as the malignant and fatal exhalations of pestilence, the putrefaction of organic substances. Hence it is no more the gift of the Creator than is the malarial poison that breathes its contagion and strikes down the young and old with disease and death."

To continue life in the body, we must take into it the products of life, not of putrefaction. Alcohol contributes no substances that form tissue, and when eliminated from the excretory organs it is still alcohol. It is thrown out through the pores of the skin, through the lungs and the kidneys and always unchanged in form. Dr. James Kirke, of Scotland, says that in the case of a man who died in a state of intoxication, the fluid found in the brain smelled of alcohol, and actually burned with the same blue flame characteristic of this poison. Dr. Ogsden of Aberdeen, examined the body of a woman who died while intoxicated, and found in the heart nearly four

ounces of fluid having all the qualities of alcohol. Dr. Percy, of Nottingham, England, was not willing to rely upon the odor, or inflammability of fluids after death, but by distillation he produced from these fluids that which, when treated chemically, proved to be alcoholic. He had no difficulty in extracting alcohol from the blood, from the substances of the brain, from the liver and the bile. It must not be supposed, however, that Alcohol leaves the body just as he found it. Everywhere he goes he leaves traces of his destructiveness. In the first place, he is a thief of water, and begins his robbery as soon as he enters the house. He takes water away from the mucous membrane of the mouth, giving a puckered feeling, more or less severe, according to the dilution of the alcohol. This abstraction of water takes place throughout the body wherever Alcohol goes.

You will remember that the blood slips through the walls of the capillaries into the tissues, and waste material in the same way passes from the tissues into the blood, and by this process of osmosis the body is nourished and kept in repair. Alcohol makes these membranes stiff and hard so that the blood cannot readily pass through them. People sometimes say that they get fat drinking beer or wine. In truth they are filled

up with waste matter that cannot slip through the stiffened membranes into the blood to be carried out of the body, and that certainly is not a very desirable state of affairs. If people are dying every day in the house, we know that they must be taken away or their presence will create disease. If our bodily servants, the cells, which are constantly dying, cannot be carried away, they are like an accumulation of corpses in the house. They may fill up all the spaces and stretch the body to its utmost, but they are dead and their presence must provoke disease. If the tissues cannot obtain proper food, they degenerate and become fatty, and they cannot get food if the membranes are hardened by alcohol ; so that people may get fat while taking alcoholic beverages through this fatty degeneration.

Alcohol tends to produce fat also by consuming the oxygen which should have been used in oxidizing fat. We are told that two ounces of alcohol taken in twenty-four hours will not be eliminated, but will disappear somewhere in the body, and some claim that this proves it to be a food ; while others claim with equal positiveness that its retention in the body is productive of evil, by interfering with the processes of nutrition. Upon this point N. S. Davis, M. D., says, "The individual who increases his weight and

bulk by taking just enough of the weaker alcoholic drinks to retard the process of secretion and waste, in the same proportion diminishes his activity, his power of endurance, and his ability to resist the effects of morbid agents of every kind."

Sometimes alcohol has the effect of making the membranes full of holes so that they let the nourishment of the blood leak out of the body through the excretory organs. In this way the kidneys may carry away the building-up material, leaving the body to fall into ruin, not because food is not taken, but because, by the action of alcohol, food is lost. The form of kidney difficulty known as Bright's disease is of this character.

Everywhere through the house alcohol goes with the blood into all the minute capillaries. And what does it do to the blood? It may cause the little red corpuscles to cling together in clots, and these clots may lodge somewhere in the blood vessels, stopping the circulation through that part and causing it to die; or they may go to the lungs and stop the circulation there; or to the heart and prevent its action; or to the brain and produce apoplexy. Alcohol changes the shape of the red corpuscles, interferes with their power to slip through the blood vessels and to carry oxygen to all parts of the body.

But alcohol helps digestion, you say. What is the report of science on this point? Dr. Beaumont again gives us valuable information. He observed that whenever St. Martin drank any alcoholic beverage, whether it was beer, wine, or stronger drinks, the coat of the stomach became inflamed, and when he had been drinking freely for some days there were ulcerous patches which increased with the amount of drink.

People sometimes say they are sure that alcoholic drinks do not hurt them, because they are not conscious of any disturbing effect, but even when Dr. Beaumont saw these ulcerous patches in the stomach of St. Martin, the man himself had no pain. If the doctor had judged by St. Martin's feelings, he would have said no harm was being done, but the stomach told another story. When liquor was abandoned, the stomach was gradually restored to the healthy state. Dr. Beaumont says, "It was not ardent spirits alone that produced these changes, but even wine and beer. Nor are these changes indicated by any ordinary symptoms, or particular sensations; their existence was only ascertained by ocular demonstrations."

But if a stomach, inflamed by alcohol, should complain, the man usually argues that it is a call for more drink. If he takes the drink, he feels

the gnawing lessened, and then argues that the drink is beneficial. The truth is that the alcohol deadens the sense of discomfort by a partial paralysis of the nerves of sensation, and as soon as they have recovered from this paralysis, the feeling of uneasiness returns. This process repeated year after year may result in serious disease, perhaps even in cancer.

Alcohol not only irritates the mucous membrane of the stomach but it precipitates the pepsin. What does that mean? Well, it means this: There is in the gastric juice an active substance called pepsin which has the power to digest food. When alcohol is taken, it causes this pepsin to separate from the gastric juice, to settle as a sediment, and to lose its active power. It is as if it took the knives and other culinary utensils out of the hands of the cook, threw them in a heap on the floor, and claimed that that was helping the cook to do his work.

Dr. J. H. Kellogg, in his studies of the effects of various substances on the process of digestion, finds that alcohol always hinders stomach digestion. As it hardens the albumen in living tissue, so it also hardens the albuminoid substances which are taken as food, and so makes them more difficult to digest.

When one has eaten a big dinner and feels

uncomfortable, he may feel relieved by taking a drink of some alcoholic beverage, but that is because the nerves of sensation are deadened, and not because the dinner is being better digested. The nerves of sensation being deadened, keep quiet and make no further report of trouble, and because he hears no report, Man thinks matters are going on in a better way, which is not true. Alcohol plays the mischief everywhere with the nerves. He paralyzes those that govern the size of the blood vessels, and the blood rushes in and dilates the capillaries, and stays there. This causes the flushed face and red nose which, in time, become chronic. To insure the health of an organ, the blood must circulate through it, and for the blood to stagnate in it is just as much starvation to the organ as if not enough blood were called there.

But again, you will say alcohol warms people when they are cold. It causes a feeling of heat on the surface, while it takes heat from the interior of the body. The experience of Arctic explorers demonstrates that alcohol diminishes the power of enduring extreme cold.

Sir John Richardson, M. D., of the English Arctic expedition, says: "I am quite satisfied

that spirituous liquors diminish the power of resistance to cold. Plenty of food and sound digestion are the best sources of heat." The experience of twenty-six men traveling in the far West, well provided with food, clothing, and whisky, but with no means of building a fire, illustrates the deceptive nature of alcohol in keeping men warm. Their experience was severe, and those suffered most who drank most. Those that became intoxicated froze to death; those that drank less lived through the night, but died after a time; those that drank moderately survived, but will feel the effects of their experience as long as they live. The three men who survived without any serious effects, were the three who through the whole time never drank a drop. These men were all Americans between twenty-three and forty-one years of age; all were equally provided with blankets; all were in good health, the only difference being in the amount of liquor which they used.

Dr. N. S. Davis proved by an extensive series of experiments, that during the digestion of food the temperature of the body was increased, but when any alcoholic beverages were taken, the temperature began to fall within half an hour, and continued to decrease during two or three

hours, and the reduction of the temperature in extent and duration was in direct proportion to the amount of alcohol taken.

The drunken man is a poisoned man; this is proven in various ways. He staggers because the nerves of motion are partly paralyzed and will not convey his will to his muscles. In the trembling limbs of the confirmed drunkard, we see this condition become chronic.

The effect of alcohol upon the heart is marked. It interferes with its steady pumping, the action becomes more and more rapid, therefore time for rest is lessened, and this wears the heart out faster than is necessary. Experiments have proven that if a man drinks only one fluid ounce of alcohol a day, his heart will beat four hundred and thirty times oftener than it does normally, and eight ounces will cause it to beat about twenty-five thousand times oftener than it should. Even two ounces of alcohol, evenly distributed throughout the day, will raise the number of heart beats by about six thousand. This increased rapidity of the heart's action is, in large part, due to the effort made to get rid of the poison. The increased rush is partly due also to the paralyzing of the nerves of the capillaries. By this means the blood rushes in such quantity to the surface, that it makes the

heart feel it necessary to pump more blood, and so it runs faster and more irregularly until perhaps it is entirely exhausted.

The kidneys are seldom found in a healthy condition in a drunkard, or even in a moderate drinker. Dr. Christison, of Edinburgh, says that nearly four fifths of the cases of kidney diseases which he has had to deal with were in persons who were real drunkards, or else used alcoholic liquors constantly, though perhaps never becoming really intoxicated.

The liver is the organ first affected by the use of alcohol. It becomes greatly enlarged in size through being loaded with fat. We have studied the wonderful work done in the liver and can readily understand that if its healthful action is interfered with, the whole body is more or less disturbed. Alcohol changes the secretion of bile from a bright yellow color to green, or almost black, and from a thin fluid to one the consistency of tar. It hardens the liver tissue until, as Hargreaves says, "The liver sometimes becomes full of unabsorbed matter which forms in spots and consists of a kind of consolidated pus, such as is seen to form under a scab, or when an ulcer is opened. These little spots at first may not be larger than a pin-head, but as the inflammation increases, two or more unite to form a

larger spot, and these grow until at last the whole liver is changed in color." Poultry dealers sometimes mix alcohol with the food of fowls in order to increase the size of their livers. The examination of drunkards after death discloses horrible things concerning the effect of alcohol on the liver. Sometimes the substance is covered with tubercles, and the blood vessels are entirely destroyed, showing that circulation had ceased even before death. Sometimes the liver is covered with lumps, sometimes with fungus growths. This increase of the size of the liver, together with the stretching of the stomach in men who drink large quantities of beer, changes the beautiful outlines of the body, and they become coarse and unsymmetrical, and yet although the external appearance may indicate unhealthful conditions, the individual may feel no pain.

Dr. Trotter says of chronic disease of the liver that it is not painful, is slow in its progress and frequently gives no alarm until some incurable affection is the consequence; so that the liver and stomach of the moderate drinker may be seriously diseased while the man imagines himself to be in good health.

But we have not yet recited all the evil effects of alcohol. It is carried to the brain through

the circulation, and there sets up its peculiar poisonous action, paralyzing the nerves, and, to a great extent destroying the substance of the brain itself. We remember that the brain is of a jelly-like consistency, and we learn that all the substances of which it is composed, except its albuminous frame-work, are soluble in warm alcohol ; so that the brain of the drinker becomes smaller and harder, and less capable of doing its desired work. As a result, we may have the production of apoplexy, epilepsy, insanity, or imbecility.

Dr. Pliny Earle, of the Lunatic Hospital, Northampton, Mass., says, "There are at least five distinct varieties of mental derangement which own alcoholic intemperance as their direct and efficient cause."

The same plea is made for alcohol as for tea and coffee, that it checks waste, and therefore is an indirect food ; but we may bring the same arguments to bear as used in regard to those articles, that the checking of normal waste is not desirable. If alcohol is taken into the system and checks waste, the products of waste are then retained in the body and may, in time, produce disease. Dr. Campbell, of Edinburgh, says, "It seems to me a remarkable fallacy that physiologists should persist in talking of the propriety

of sparing tissue, inasmuch as the proper function of tissue is its destruction, and life the resultant of the change. Indeed, when any tissue is unduly retained in the system, it may of itself constitute the material of disease."

All the activities of life result in destruction of tissue, and this creates a demand for the material of which new tissue can be formed. This is why exercise makes us hungry. We should not be so anxious to prevent waste of tissue as we should be to see that all waste is duly eliminated and the destruction repaired by the digestion of wholesome food.

Dr. Parkes says: "When beer is taken daily in excess, it produces gradually a state of fulness and plethora of the system, which probably arises from a continual, though slight, interference with elimination of both fat and nitrogenous tissues. When this reaches a certain point, appetite and the formative power of the body is impaired. The imperfect oxidation leads to excess of partially oxidized products, such as oxalic and uric acids. Hence many of the anomalous affections classed as gouty and bilious disorders, are evidently connected with defects in the retrogressive metamorphosis."

One of the strongest evidences that alcohol is a destroyer of life is found in statistics of the

mortality of intemperate people compared with that of temperate.

Life insurance companies will not insure the lives of intemperate people, but they will insure moderate drinkers. The Temperance Provident Institution insures no one but total abstainers, and from the statistics of this society it seems that total abstinence from alcoholics reduces the death rates at least one half.

Some years ago Mr. Locke, better known as Petroleum V. Nasby, caused the physicians of the city of Toledo, O., to be interviewed in regard to their opinion of alcohol. The universal statement was against its use. One physician had especially noticed the sudden death of men in the prime of life, who outwardly bore a healthy appearance and yet suddenly fell victims to pneumonia, apoplexy, heart difficulty, or Bright's disease, and observed that they were principally drinkers of beer.

An army surgeon said it would be difficult to find any part of a beer drinker's machinery that is doing its work as it ought. Medical men dread even moderate drinkers as patients. Surgeons learn that men who are in the habit of using alcoholic beverages will not easily recover from even slight surgical operations.

As alcohol is supposed by many to be a specific

remedy in cholera it might be interesting to study the testimony of physicians on this point. Hargreaves says, "Alcoholics tend to produce a condition in the system resembling cholera by changing the arterial blood into venous without the substance of the tissues having taken any share in the transformation." A Warsaw physician says concerning an epidemic of this disease, "Cholera, up to the present period, has respect for persons who lead regular lives, and has struck without pity every man worn-out by excess and weakened by dissipation." Professor Mackintosh says, "It has been computed that five sixths of all who have fallen by cholera in England were persons of intemperate habits."

Mr. Bronson, of Montreal, says: "The habitual use of ardent spirits in the smallest quantity seldom fails to invite cholera and to render it incurable when it takes place." Dr. Adams, of Glasgow, says: "I have found the use of alcoholic drinks to be a great pre-disposing cause of malignant cholera. So strong is my opinion on this point that had I the power I would placard every spirit-shop in town with these words, 'CHOLERA SOLD HERE.'" The testimony is overwhelming that abstainers are comparatively safe in epidemics of cholera.

I used often to be asked why beer-drinking nations are so much more healthful and less

inclined to drunkenness than the nations that use no beer. Before I went abroad I did not know how to answer this, now I can answer it by saying that the question implies that which has no foundation in fact. Beer-drinking is not conducive to health in any country, and drunkenness prevails wherever beer is used. I saw more intoxication among both men and women in beer-drinking England than I ever saw in America, and a six months' stay in the homes of English families proves to me that they suffered in health from this cause.

Dr. Kerr says: "Beer-drinkers are especially liable to structural alteration and enlargement of the liver, often complicated with dropsy, rheumatism, and gout. Among the consequences of beer-drinking are an impeded and loaded circulation, embarrassed respiration, functional perversion, hepatic and renal congestion, with a stupor tending toward paralysis, and a diminished vitality which invites disease and easily succumbs to its ravages." He also adds that beer-drinking has, in the long run, a depressing effect tending to melancholy, sometimes ending in suicide. This is certainly not a very good recommend for beer.

The cultivation of vineyards and the manufacture of wines are advocated by some as a means of preventing drunkenness, but observa-

tion of wine-drinking in various countries proves this to be a mistake. All wines have a greater or less amount of alcohol in them, and many wines are made so strong by the addition of an extra quantity of alcohol that they are almost equal to distilled liquors. They tend to the production of all the diseases which alcohol can produce.

I found in countries where drinking is common among all classes that a prejudice exists against total abstinence. It was thought an evidence of a weak brain if a person could not "drink or let it alone" as he pleased; we find, however, that the strong brain is the one that is not poisoned by alcohol. Many a man imagines that he can stop drinking till he makes the effort, and then learns that his will-power is so weakened that he is not his own master. Alcohol is a most effectual destroyer of the power of self-control. As Dr. Kerr says, "The shiftless, unstable victim is tossed about on the ocean of inebriate excitation like a rudderless ship in a storm." It is the strong man who refrains, the weak man who yields.

Alcohol is sometimes taken under the supposition that it increases mental power, and it is true that by the paralysis of the nerves that control the blood vessels, a greater amount of blood

will pass to the brain and there will be a temporary increase of activity, though, in reality, the quality of work is often found to be below par. At this time there may be excitement or even brilliancy, which may increase until it reaches frenzy or delirium, but as we have already learned, an organ cannot be nourished by stagnant blood, and this increased quantity of blood carried to the brain and remaining there leaves the brain without nourishment, and the "brilliancy dies away, the memory fades, speech is thickened, voluntary movements cease, sensation is dulled, and conscience fails." Now, of course, the intellect is weakened, and the moral sense is lessened. The man does not feel keenly, and will not realize the extent of injury done to him. His perception of truth and justice and morality is gone and he may murder his wife or children while in this condition, and be horrified at the deed when he is restored to his normal state.

In our study of the telegraph, we saw that certain parts of the brain control certain portions of the body, and it is now conceded that one part of the brain is intimately connected with the digestive apparatus in the recognition of the necessity for food. This brain center, repeatedly irritated and poisoned, creates a de-

praved appetite which calls for the paralyzing effect of the same substance that has produced the evil. If the use of alcoholic liquors is begun in youth, the effect is just so much the more injurious; and we have the testimony that in beer drinking countries the habit of alcoholic liquors among children is continued even to the production of drunkenness.

So alarming has been the increase of drunkenness among children attending school in Austria, that the Vienna school-board have been making an effort to induce the government to prohibit the sale of liquors to children under fifteen.

In England, it is reported that children of seven years old have been treated for *delirium tremens*. Dr. Kerr relates several cases of delirium among children, saying that babies of not more than two years of age would cry for their daily allowance of spirits. He also asserts that the use of wines for breakfast and dinner by children is leading to inebriety.

Everything that lessens nutrition and depresses physical powers paves the way to indulgence in alcohol. So, bad air, impure food, overwork, and mental strain may be classed as provocative of the use of alcohol. On the other hand, we may enumerate pure air, good food, cheerful surroundings, and exercise as among the

most valuable remedies, and better still as preventives.

The loss to the nation through alcohol can scarcely be estimated. We are told that in the United States one hundred thousand persons die every year as drunkards. It is calculated that for every death there are fifty cases of illness. Add to this the loss of life resulting from the frenzy of intoxication; from the inefficiency of drunken men in responsible positions; of children mutilated or crippled or smothered accidentally by drunken parents, and the loss becomes appalling.

The extravagant expenditure of money is also a question seriously to be considered. It is estimated that nine hundred million dollars a year is expended in the purchase of alcoholic beverages, and that it costs the United States not less than sixty million dollars a year to support pauperism and crime, produced mostly by alcohol. Penitentiaries, reformatories, jails, and inebriate asylums are all sources of expenditure which would be greatly lessened if total abstinence prevailed. I shall only be able to indicate in these pages a very small amount of the actual evils caused by the use of alcohol.

If some man came into our house, no matter how elegantly dressed or with what polished

manners, and at once began a destruction of our most precious treasures, even of our dwelling itself, it would not take us very long to rid ourselves of the intruder. When we look over the charges brought against this titled adventurer, King Alcohol, when we see that from the very first moment of his entering our bodily dwelling he begins his work of destruction and continues it in all parts of the body, tearing down, destroying, paralyzing, and utterly ruining, would we not be showing ourselves wise if we set ourselves firmly to oppose the admission of Alcohol in every disguise, never suffering ourselves to be deceived by his pretentions, but accepting as true the Biblical statement, "Wine is a mocker, strong drink is raging ; and *whosoever is deceived thereby is not wise*" ?

INDEX.

Page.

Abdomen 18
Absorption of food 66
by the lacteals 66
Absinthe 218
Air, atmospheric, composition of 95
changes in respiration 93
complemental 94
residual 94
reserve 94
tidal 94
natural purification of 96
Air-cells 94
number of 96
Albumen, action of alcohol on 253
Albuminoids 59, 196
Alcohol 243
produced by decomposition 245
effect of on membranes 249
on corpuscles 251
on nerves of capillaries 254
brain 258
heart 256
kidneys and liver .. 257
mental powers 265
pepsin 253
sensation 254

Page.

Alcohol.—*Continued.*
effect of on stomach 252
heat of body 255
testimony of Arctic explorers concerning. 254
testimony of physicans concerning 253
diseases produced by 259
use of by children ... 266
loss to the nation through 267
not a food 248
checks waste 259
Anvil 160
Aorta 72
Arachnoid membrane 45
Arteries 76
movements of blood through 77
Attitude 29
Aura 14
Auricles of the heart 71
Bathing, rules for 36
Beer 262
Bile, secretion of 62
function of in digestion 62
Blood 75
absorption of oxygen 77
change of in respiration 86, 92

Blood.—*Continued.*
color of 77
corpuscles of 77
coagulation of 78
circulation of 78
exposure to air in lungs 93
fibrin of 77
Blood corpuscles 77
movement of in capillaries 78
Body, temperature of 101
Bones, number of 17
formation of 21
composition of 20
uses of 17
Brain 47
cranial 123
abdominal 123
motor area of 116
cells of 114
convolutions of 48
membranes of 45
structure of 47
nerves of 115
Breathing 93
diaphragmatic 89
Bronchial tubes 86
Camera, the photographic 143
Capillaries 77
circulation in 78
Casein 59
Cells 80
work of 82
Cerebro-spinal nervous system 115
Cerebrum 48
office of 119
Cerebellum 48
a regulator 120
office of 119, 126
Chamber of Envy 186
Hatred 185
Love 187
Peace 185
Selfishness 186
Chloral hydrate 217
Chords, vocal 167
Choroid coat of the eye .. 145
Cigarettes 221
Cholera produced by alcohol 262
Chyle 65
Clock, the wonderful 122
Cocaine 218
Cæcum 68
Colon 67
Color, how produced 156
Color-blindness 157
Cochlea of ear 161
Coffee, effects of 208
use of by children ... 210
Condiments 203
Conjunctiva 140
Convolutions of brain 48
Cornea 145
Corpuscles of blood 77
Cupola, the 43
Deceitful friend, a 220
Diaphragm 89
action of in breathing 89
Dining-room, the 63

Drum of ear..... 159
Ductless glands 111
Duodenum 61
Dura Mater 45
Ear 159
tympanum of..... 159
bones of..... 160
Eggs..... 196
Elasticity of muscle..... 26
Electrical apparatus, the.. 114
Endosmosis 100
Epiglottis 85
Eustachian tube..... 159
Exercise..... 99
Exosmosis..... 100
Extensors 28
Eye, a camera 143
blind-spot of..... 150
choroid coat of..... 145
retina of 144
sclerotic coat of..... 145
Fermentation 246
Fibers, muscular 26
Fibrin of the blood 77
Flexors 28
Foe of the household 243
Food, action of saliva on. 56
of gastric juice on... 59
of pancreatic juice on 61
of liver on 105
intestinal juice on ... 64
Framework, the..... 17
Force-pump, the 69
Fruits..... 197
Function of bones 17
muscles 23
Function.—*Continued.*
teeth 51
gastric juice 56
pancreatic juice 61
villi 65
intestinal juice..... 64
bile 106
blood-corpuscles..... 77
lungs 87
heart 71
retina. 144
Ganglia of spinal cord ... 115
of sympathetic nerves 124
Gases, oxygen 95
carbonic acid 92
diffusion of..... 95
Gastric juice..... 56
Glands, definition of..... 100
salivary 54
perspiratory 34
pineal and pituitary.. 110
ductless 111
thyroid and thymus.. 111
Gluten..... 59
Glycogen 106
Gray matter of brain 48
Gustatory sense 54
Hair 41
Hammer 160
Hearing, sense of..... 133
range of 164
Heart 70
capacity of 72
cavities of..... 71
location of 69
work of..... 72

Heart.—*Continued.*
rest of 73
valves of..... 71
Heat, source of..... 97
exercise produces.... 99
digestion produces... 99
thought produces.... 100
Heating apparatus, the... 97
Helpful guests 193
Housekeeper's closets, the 108
Ilium..... 63
Incisors..... 52
Internal ear..... 162
Intestinal juice..... 64
Intestines, small..... 65
villi of..... 65
large 67
Iris..... 142
Jejunum 63
Jugular vein 67
Juice, gastric 56
intestinal..... 64
pancreatic..... 61
Kitchen, the 56
Laboratory..... 103
Lacteals 66
Larynx, the..... 86, 166
Library, the..... 172
Lime in bones..... 21
Liver..... 100
work of 105
Lungs 88
capacity of..... 96
Lymph 84
Lymphatic gland..... 66
vessels..... 67
Medulla oblongata..... 128
Membranes, mucous..... 51
passage of fluids through 100
Memory, a library..... 172
a picture gallery..... 182
cultivation of..... 176
rules for improvement of..... 179
of senses 178
Mesentery, the..... 66
Milk 195
Molars..... 52
Mouth 50
Mucous membranes..... 51
Muscles, strength of... . 25
properties of..... 25
irritability of..... 25
elasticity of..... 26
contractility of..... 24
flexor and extensor .. 28
Muscular fibers..... 26
Muscular sense..... 138
Music room, the..... 158
Nasal fossæ 85
Nerves..... 114
of motion 115
of sensation 119
Nerve force, rapidity of .. 120
Nervous system, cerebro-spinal..... 115
office of..... 123
sympathetic, office of 123
Nervous fibers, motor 115
Net-work, capillary..... 78
Nicotine 222

Nicotine.—*Continued.*
effect of on blood.... 224
on heart..... 226
Office, the general..... 47
Opium..... 215
Orchestrion, the..... 165
Organic substances as food 59
Osmosis..... 100
Ossification..... 21
Otoliths..... 161
Oxygen..... 194
Pain, a friend..... 215
Pancreas..... 62
Pancreatic juice, uses of.. 61
Palate, soft..... 55
Papillæ of the tongue.... 134
Pelvis..... 18
Pericardium..... 71
Peristaltic action..... 124
of stomach..... 56
of bowels..... 124
Perspiration, uses of..... 34
insensible..... 34
amount of..... 35
Perspiratory glands, length of..... 34
Pharynx..... 55
Phosphorus..... 198
Pia mater..... 45
Picture gallery, the..... 182
Pigment of skin..... 39
Pineal gland..... 110
Pitch of voice..... 168
Pituitary body..... 110
Pleura..... 88
Plexus..... 123
Plumbing, the..... 33
Pons varolii..... 126
Pulse, frequency of..... 70
Pupil of eye..... 141
Purifying apparatus, the.. 85
Pylorus..... 58
Receptaculum chyli..... 66
Reception Room and Hall 50
Red corpuscles..... 77
Regulator and Mainspring, the..... 126
Repose, need of..... 70
Reserve air..... 94
Residual air..... 94
Respiration..... 89
changes of blood in.. 92
frequency of..... 93
Retina..... 144
Rhythmic action of organs 124
Round shoulders..... 30
Saliva, action on starch.. 54
Salivary glands..... 54
Salts..... 198
Schneiderian membrane.. 85
Sclerotic coat of eye..... 145
Semi-circular canals..... 160
Senses, sight..... 132
taste..... 134
smell..... 135
hearing..... 133
touch..... 133
Sense, muscular..... 138
Servants, the..... 80
Sheathing..... 38
Sight, sense of..... 132
mechanism of..... 147

Sight.—*Continued.*
attributes of objects by..... 154
Skin, structure and use of 40
coloring of..... 39
Smell, sense of 135
Sound, how produced ... 163
Sound-vibrations, rapidity of..... 164
Special Watchmen 132
Spicy Visitors..... 202
Spinal column..... 18
Spinal cord..... 114
nerves of..... 115
Spleen..... 112
supposed office of ... 113
Starch, digestion of in mouth 54
Stirrup..... 160
Sternum 18
Store-room, the 61
Stomach, coats of 56
secretion of..... 56
action of..... 56
structure of 56
temperature of 57
Sweat glands 34
Sugar, formation of in liver..... 106
Supra-renal capsules 111
Sympathetic nervous system, origin of 123
Taj Mahal 16
Taste, sense of..... 54
where located 134
Tea, effects of 211
Tears, uses of..... 141
Teeth, development of... 52
care of..... 53
Thatch, the 41
Thoracic duct..... 67
Thorax 18
Throat..... 55
Tidal air 94
Tobacco 221
effects of on blood... 225
ears 229
eyes 228
heart 226
intellect..... 230
morals 232
nerves 227
lungs 224
throat 229
what science says of. 221
Tobacco-habit, breaking off 237
of girls 238
cost of 239
Tone 168
loudness of..... 168
pitch of..... 168
duration of..... 168
quality of 169
Tongue, nerves of..... 134
Tonsils 110
Touch, sense of..... 134
Trachea 86
Treacherous companions. 214
Tympanum..... 159
Uvula 55
Valves of the heart..... 71

Veins..... 76
Vegetarians 200
Vena cavæ ascendens. ... 76
descendens..... 76
Venous blood, changes in respiration 92
Velocity of blood in arteries..... 78
capillaries..... 78
Ventricles of heart 71
Vestibule of internal ear.. 160
Vibration of air-waves.... 163
vocal chords..... 167
Villi of intestines..... 65
Vitreous humor 144
Vocal chords 168
Voice, range of..... 170
Walls and machinery 23
Water..... 197
proportion of in food 60
in body 60
White corpuscles..... 113
Windows..... 140

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